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Emerging Aesthetic Trends in Product Design: Exploring Novelty, Technology, and Sustainability

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Abstract:
This study examines how aesthetics, technology, and sustainability can be effectively integrated into product design to meet changing consumer preferences. Using a thematic review of literature published between 2020 and 2024, the research identifies key trends and regional differences in design practices, focusing on the dimensions of novelty, technology, and sustainability. A systematic approach was applied to analyse 21 articles selected from SCOPUS, ScienceDirect, and Emerald Insight. The findings highlight how technology-driven innovation, emotional engagement, and sustainable design practices influence product aesthetics in regions such as East Asia, Australia, and Western countries. These trends show the growing importance of balancing creativity, functionality, and environmental responsibility.

Based on these insights, the study proposes a framework with five guiding principles: Localized Innovation, Technology Synergy, Sustainable Aesthetics, Emotion-Driven Design, and Cultural Adaptability. This framework offers practical guidance for designers to create products that combine aesthetic appeal, technological innovation, and sustainability. The research provides valuable insights into global design trends and supports the development of design strategies that respond to diverse cultural and consumer needs.

Keywords:
Product Aesthetics, Thematic Design Trends, Technology in Design, Sustainable Innovation, Consumer Preferences

1 Introduction

Thematic Design Trends are increasingly becoming a focus of study as they reflect the evolving dynamics in consumer preferences and product aesthetics. Shi et al.(2021) and Mridha et al. (2022) emphasize that a product's aesthetic attributes significantly influence consumer behavior, prompting consumers to equate high

design aesthetics with superior value and trustworthiness. In hyper-competitive markets, visually appealing designs stand out, driving purchase intentions and fostering brand loyalty. Nevertheless, this raises questions about how aesthetic appeal must balance with functionality, a relationship that remains underexplored in the current literature. Moreover, technology in design plays a crucial role in shaping modern aesthetic trends. Ouyang (2023) and Zhou et al.(2022) note that advancements such as computational aesthetics have transformed product design, allowing for the creation of forms optimized for visual appeal without compromising functional efficacy. Despite these advancements, there remains a knowledge gap in understanding how these technologies are assimilated across different cultures and how visual appeal can be harmonized with other cultural and ergonomic principles. Sustainable Innovation in design further introduces a new dimension to aesthetics. Daugelaite & Gražulevičiūtė–Vileniškė, (2021) and Gao (2024) posit that integrating sustainability with aesthetics not only draws consumer interest but also taps into desires for authenticity and cultural connections. This trend underscores a shift towards environmentally responsible aesthetics, yet the literature still lacks comprehensive frameworks that address how sustainable aesthetics can be universally applied across diverse consumer segments and regions. In synthesizing these viewpoints, it becomes evident that while product aesthetics, technology, and sustainable innovation are pivotal to consumer engagement, there is a need to develop a more integrated framework that encapsulates these elements within different cultural and industry contexts. Mridha et al.(2022) highlight the significance of cultural context in shaping consumer behaviour and aesthetic appreciation. Despite these insights, a cohesive model that unites these diverse thematic trends into universally applicable design principles is yet to be realized. In conclusion, thematic design trends reveal a complex interplay between consumer preferences, technology, aesthetic appeal, and sustainability. The current literature offers fragmented insights into these dynamics; however, it calls for a unified framework that accommodates these multidimensional aspects across varied cultural landscapes. Such a framework would not only bridge existing gaps but also provide a comprehensive understanding of global design principles, ultimately guiding more effective product development strategies.

The central theme of this research is the intersection of aesthetics, technology, and sustainability in product design. A significant event that highlights this theme is the increasing consumer demand for products that are not only innovative and visually appealing but also environmentally responsible. This study will approach the topic from the perspective of identifying universal principles that can guide product designers across different industries and regions. The aim is to address the problem of how designers can effectively integrate novelty, technology, and sustainability into their creations to meet evolving consumer preferences.

RQ: How can product designers effectively integrate aesthetics, technology, and sustainability to create innovative products that align with evolving consumer preferences across various industries?

Sub RQ1: What are the patterns and trends in emerging aesthetic design features focusing on novelty, technology, and sustainability in products across various regions?

Sub RQ2: What principles can be identified from emerging aesthetic trends in product design that can guide the development of a framework integrating novelty, technology, and sustainability across different regions?

2 Literature review

2.1 Novelty in Product Design Aesthetics

Research conducted by Shi et al. (2021) highlights the important relationship between design aesthetics and consumer perceptions of quality and trust, noting that appealing designs can mask functional limitations. Similarly, Hu et al. (2022) emphasize that aesthetic design principles play a crucial role in product development, enhancing perceived quality and associating functionality with design. Despite the focus on different aspects, both viewpoints suggest a significant dependency between high aesthetic appeal and consumer perceptions of value, indicating a gap in understanding how these factors play out across diverse consumer segments. Pandey (2022) and Kuys (2023) address the interplay between aesthetics and consumer preferences from the angle of market competitiveness and cultural influences, respectively. Pandey (2022) argues that in saturated markets, aesthetic appeal captures consumer attention and supports long-term loyalty. Meanwhile, Kuys (2023) examines how cultural and individual factors shape aesthetic preferences, suggesting that culturally resonant designs can enhance product appeal. These insights reveal a gap in existing literature concerning how universal aesthetic principles could be adapted to cater to both competitive markets and cultural nuances. Zhang (2024) expands on the cultural dynamics discussed by Kuys (2023) by asserting that integrating traditional design elements can increase a product's perceived novelty and desirability. This complements (Yang et al., 2021), who stress that aesthetic experiences linked with emotional responses drive impulsive purchasing behaviors. While these perspectives enrich the understanding of novelty in aesthetics, there remains a gap in exploring how cultural integration in design can foster lasting emotional connections, potentially bridging superficial novelty with deep-seated desire. From a psychological viewpoint, Yang et al. (2021) and Qi (2024) converge on the notion that aesthetic experiences are important in fostering impulsive purchasing behaviors, albeit through different mechanisms. Whereas Yang et al. (2021) focus on the emotional stimulation provided by aesthetic experiences, Qi (2024) underscores the balance between familiarity and originality in design. The apparent gap here lies in integrating these viewpoints to form a comprehensive strategy that effectively combines emotional engagement with optimal levels of novelty and familiarity. Lastly, despite acknowledging the pivotal role of aesthetic appeal, Shi et al. (2021) and Pandey (2022) both highlight the potential of design to compensate for functional deficiencies and foster loyalty. However, neither fully addresses the sustainability of such strategies in dynamic markets with evolving consumer preferences. There is a gap in the literature on how design strategies can remain evergreen in the face of shifting underlying consumer motivations guiding both perceptions of value and purchasing decisions.

2.2 Technology in Product Design Aesthetics

Shi et al.(2021) underscore the role of aesthetics in enhancing perceived value and trust, even compensating for functional deficiencies. This viewpoint is shared by Yang, et al. (2022), who highlight the importance of appealing designs in boosting consumer interest and sales. Nevertheless, both discussions lack a detailed examination of how technological advancements can mediate or amplify the aesthetic-value relationship, an area ripe for further exploration. Pandey (2022) points out that aesthetic considerations are vital in evoking emotional responses, influencing purchasing decisions, which is a notion echoed by Yang, et al. (2022) in their emphasis on sales and consumer interest. These analyses, however, overlook how technological innovation in design can optimize the emotional and purchasing experience, necessitating research into how advanced technologies can further integrate aesthetic and functional excellence. Cultural factors are crucial, as

noted by Li & Li (2022), in shaping aesthetic preferences, especially regarding culturally resonant designs. Although Shi et al. (2021) focus on aesthetics enhancing trust and perceived value, the integration of cultural factors into technology-driven design remains underexplored. There is a need to examine how culture-specific technology applications can tailor aesthetic experiences in products to align with varied cultural expectations and values. While integrating traditional cultural elements enhances product appeal, as observed by Li (2022), Yang, et al. (2022) focus primarily on consumer interest and sales through design. Despite this, both statements do not sufficiently address the dynamic relationship between evolving technology and static cultural elements, signifying a gap in developing frameworks that consider temporal changes in culture and technology. Ultimately, Shi et al. (2021) and Pandey (2022) both affirm the necessity of integrating aesthetic principles into design due to their influence on consumer trust and emotional responses. However, neither delves deeply into how technological progress can evolve these principles to maintain relevance in fast-paced markets. This overlooked area suggests investigating the intersection of tradition and innovation in aesthetics, leveraging technology to meet modern consumer demands.

2.3 Sustainability in Product Design Aesthetics

Yang et al. (2021) discuss how sustainability intersects with aesthetics, influencing consumer purchasing intentions. This viewpoint is complemented by (Sareh, 2023), who asserts that sustainable design enhances consumer satisfaction and loyalty. Nevertheless, both authors overlook the potential challenges of balancing aesthetic appeal with sustainability considerations, highlighting a blind spot in understanding how to harmonize these priorities across different consumer segments. Sareh (2023) and (Wang, 2024) emphasize that sustainable, aesthetically pleasing products enhance consumer experiences and drive purchase decisions. Despite this alignment, there is an apparent lack of focus on the practical applications and feasibility of integrating sustainable practices without compromising aesthetic value, indicative of the need for further research in achieving sustainable aesthetic innovation. Furthermore, while Yang et al. (2021) and Wang (2024) highlight the importance of aesthetic experiences, they do not address how sustainability could reshape these experiences in consumer minds. The gap here suggests that there is a need to investigate how sustainable innovation alters traditional notions of aesthetic pleasure and satisfaction, thus influencing consumer preferences in a rapidly changing market. Although the focus on holistic consumer experiences by Wang (2024) aligns with Sareh's view on satisfaction, there remains an unaddressed void in exploring the long-term impacts of sustainable aesthetics on consumption habits. Thus, there is an opportunity to study the sustained effects of integrating aesthetic and sustainability principles over time, contextualized within broader design trends. Despite the critical insights offered, Yang et al. (2021) and Sareh (2023) do not fully address how sustainability dynamics translate into a tangible competitive advantage for companies adopting aesthetic innovation. This gap calls for research into differentiating factors that distinguish aesthetically sustainable products in fiercely competitive markets, shedding light on new opportunities for strategic development.

Conclusively, comprehending the themes of novelty, technology, and sustainability in product design aesthetics reveals significant overlaps and gaps in understanding consumer preferences. Addressing these gaps—such as the role of technology in evolving design principles, the integration of cultural elements, and the balance between sustainability and aesthetic novelty—will require developing a robust framework. This framework should integrate insights from various disciplines and methodologies, offering a universal ap-

proach to design that captures dynamic consumer behaviors and preferences across different industries and regions.

3 Materials and Methods

The term thematic review (Figure 1) using ATLAS.ti as a tool was introduced by Zairul, (2020,2022,2023) . This method has also been copyrighted under the registration number L.Y. (Zairul, 2023). This method provides a systematic approach for analyzing existing literature by identifying patterns and constructing themes. Clarke and Braun describe thematic analysis as a process of recognizing and interpreting recurring patterns, making it a suitable framework for this study's exploration of novelty, technology, and sustainability in product design. This structured approach enhances the reliability and depth of the review, ensuring a comprehensive analysis of the subject. The process begins with the formulation of the research question (RQ) and sub-questions (see the previous section). These questions define the scope of the review and guide the identification of relevant literature. The first step involves an initial screening of articles, where studies are selected based on their relevance to the themes of novelty, technological innovation, and sustainability in product aesthetics. This screening process identifies key works across different industries and regions that align with the study's objectives. The second stage applies inclusion and exclusion criteria to refine the selection. Peer-reviewed articles published in English and focusing on the integration of aesthetics, technology, and sustainability are included. Studies that lack a connection to product design or do not address these core themes are excluded. This ensures that the final dataset is both relevant and rigorous. After finalizing the dataset, the metadata of the selected articles is meticulously checked for completeness and accuracy. This step guarantees the reliability of the dataset before moving to the analysis phase. The final step is thematic analysis, conducted using ATLAS.ti. During this phase, the selected articles are thoroughly reviewed and coded to identify key patterns and recurring themes. The analysis focuses on understanding how novelty, technology, and sustainability interact in shaping contemporary product design. Themes emerging from this process are synthesized into universal principles that can guide designers across various industries and regions. By employing this systematic methodology, the study not only explores emerging trends in product design aesthetics but also contributes to the development of practical insights for integrating innovation, technology, and sustainability in future design practices.

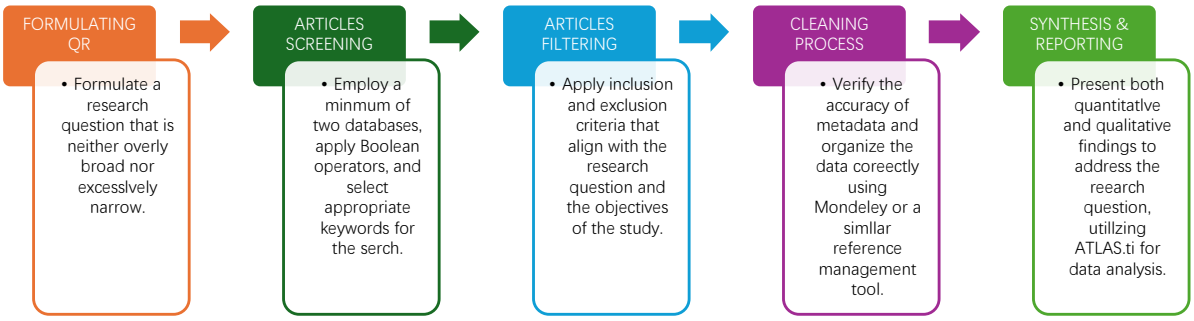

Figure 1. Thematic Review FlowZ (TreZ), copyright by Zairul (2023).

This study focuses on identifying patterns and building categories to understand trends related to novelty,

technology, and sustainability in product design, based on literature published from 2020 to 2024. The analysis aims to provide insights into emerging aesthetic trends and their implications for guiding future empirical studies. This approach helps to understand the evolutionary trajectory of these themes and highlights areas where new research directions or innovative practices might significantly influence future trends. A systematic selection process was employed to ensure that the review covered relevant and recent literature.

The inclusion criteria for selecting articles were designed to ensure a thorough and meaningful analysis. First, the review considered studies published between 2020 and 2024, reflecting the latest research in the field. Second, the search included keywords such as 'novelty,' 'technology,' 'sustainability,' and 'design aesthetics,' focusing on articles closely aligned with the study's primary themes. This strategy ensured that the selected literature provided a broad yet focused perspective on recent developments. The databases used for the review included SCOPUS, ScienceDirect, and Emerald Insight, chosen for their comprehensive indexing of peer-reviewed journals. For SCOPUS, the search used the keywords "novelty," "technology," "sustainability," and "design aesthetics" across all fields, ensuring a comprehensive retrieval of relevant studies. The search was limited to academic articles published in English and prioritized open-access publications for accessibility (LIMIT-TO (DOCTYPE, "ar"), LIMIT-TO (LANGUAGE, "English"), LIMIT-TO (OA, "all")). This approach identified 101 articles, representing a significant body of literature. The same search strategy was applied to other databases, ensuring consistency in keyword usage while accommodating differences in indexing depth, journal coverage, and algorithms. This process yielded a diverse set of articles for analysis.

The thematic review involved constructing themes and identifying key patterns from the selected literature to understand the intersection of novelty, technology, and sustainability in product design. By integrating findings across multiple databases, this review offers a robust and comprehensive foundation for further exploration of aesthetic trends and their role in shaping innovative design practices (Table 1).

Table 1 Search strings from Scopus, ScienceDirect and Emerald insight

	Search string	Results
SCOPUS	ALL (“novelty" AND "technology" AND "sustainability" AND "design aesthetics”) AND PUBYEAR > 2019 AND PUBYEAR < 2024	33
ScienceDirect	"novelty" AND "technology" AND "sustainability" AND "design aesthetics"Year:2020-2024	45
Emerald insight	"novelty" AND "technology" AND "sustainability" AND "design aesthetics"Year:2020-2024	23

The search began with carefully crafted queries aligned with the study’s objectives. The initial search retrieved 33 articles from SCOPUS, 45 from ScienceDirect, and 23 from Emerald Insight (Table 1). These results were intentionally broad to ensure inclusion of lesser-known literature. After merging the results from all databases, two duplicate entries were identified and removed, leaving a unique dataset for analysis. The finalized record list underwent a systematic screening based on the predefined inclusion and exclusion criteria. This process led to the exclusion of 78 records, and a total of 22 articles were included for final analysis (Figure 2).

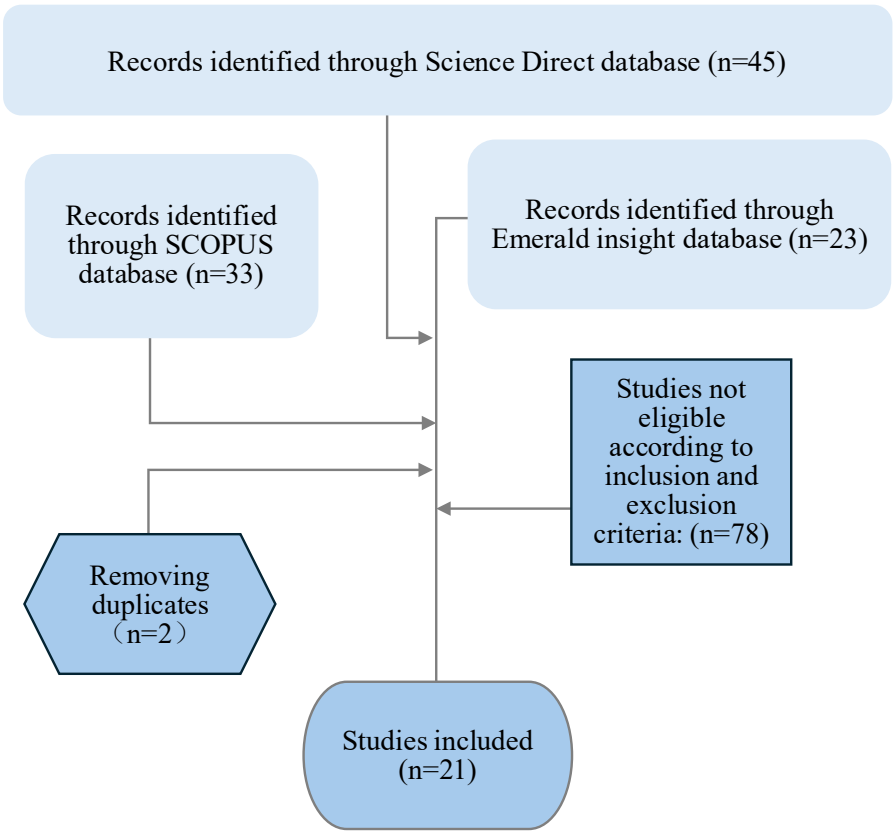

Figure 2. Inclusion and Exclusion criteria in the thematic review.

4 Results

4.1 Design Trends and Regional Focus (2020–2024): A Quantitative Analysis

From 2020 to 2024, global design trends have shown consistent growth, reflecting a heightened focus on integrating novelty, technology, and sustainability into product design (Table.2). This upward trajectory highlights a global shift towards innovative and eco-friendly practices that cater to evolving consumer preferences. Among the contributing countries, China emerged as the dominant leader, driving most of these trends with a significant influence across all years. Australia and the USA also played prominent roles, showcasing consistent contributions to advancing aesthetic and technological innovations. The year-over-year growth patterns underline the increasing global awareness of sustainable and innovative design principles. This aligns with the broader movement in industries towards incorporating unique creative elements (novelty), cutting-edge tools and functionalities (technology), and eco-conscious practices (sustainability) into product design. Overall, the analysis reveals that a select group of countries, particularly China, is leading the integration of these critical components. This dominance underscores their pivotal role in shaping the future of product design, emphasizing aesthetics that resonate with modern consumer expectations and addressing global sustainability challenges.

Table 2 Countries of research by the year

	2020	2021	2022	2023	2024	**Total**
Australia	0	0	1	1	1	3
China	0	1	1	1	4	7
Egypt	0	0	1	0	0	1
Japan	0	0	1	0	0	1
Netherlands	0	0	1	0	0	1
New Zealand	0	0	1	0	0	1
Portugal	0	0	0	1	0	1
South Korea	0	0	0	0	1	1
Thailand	0	0	0	0	1	1
Turkey	0	0	0	1	0	1
UK	0	1	0	0	0	1
USA	1	0	0	0	1	2
Total	1	2	6	4	8	21

The yearly progression of design features from 2020 to 2024 shows a steady increase in the integration of novelty, technology, and sustainability. The data reveals significant growth in 2022 and 2024, suggesting that these years marked pivotal moments for innovation in product design. The slight decline in 2023 indicates a possible period of stabilization before another surge in 2024. This trend highlights the increasing prioritization of sustainable and technologically advanced design elements, driven by evolving consumer demands and industry innovation (Figure 3).

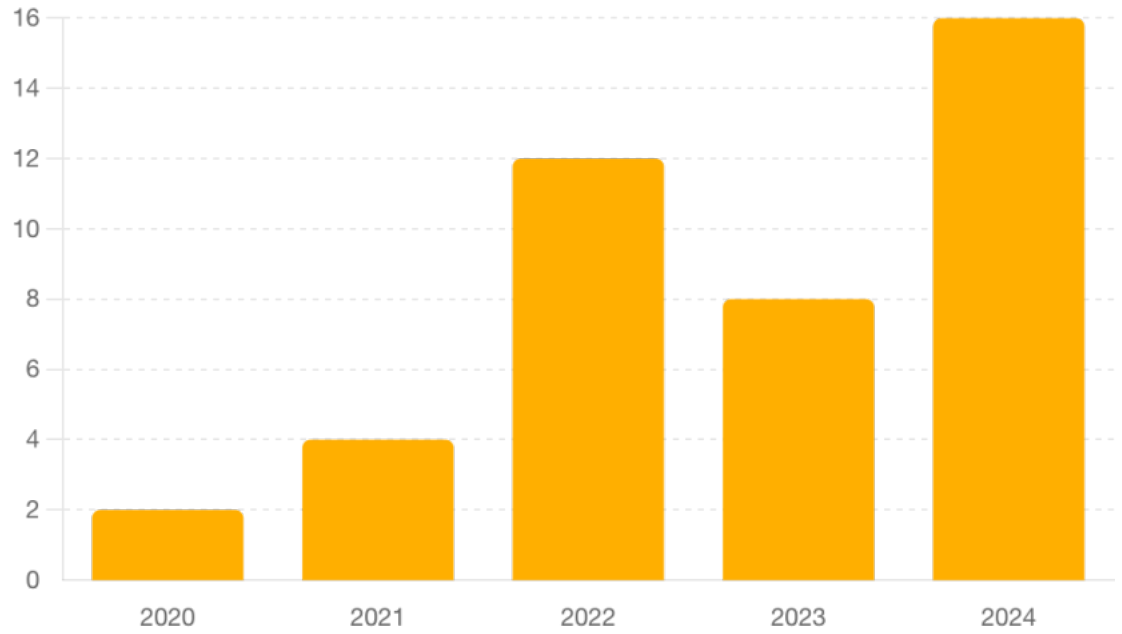

Figure 3. Design Trends From 2020 To 2024

5 Discussion

5.1 Emerging Design Trends: A Qualitative Analysis

This section examines emerging design trends using Atlas.ti for qualitative analysis (Figure 4-6). By coding and categorizing the data, three key dimensions—Novelty, Technology, and Sustainability—were identified, along with their interconnected themes (Table 3). Through open coding, initial themes such as "Innovation and Uniqueness," "Technology-Driven Decision Models," and "Form & Proportion" were extracted. These themes were refined during axial coding, resulting in three broader categories. Novelty highlights user attraction through innovative and emotionally engaging designs. Technology focuses on its role as a decision-making tool and its ability to enhance sensory experiences. Sustainability emphasizes balance, from material efficiency to cultural and environmental harmony. The analysis further revealed how these dimensions interact. Technology emerged as a critical enabler, linking Novelty and Sustainability by supporting innovative and environmentally friendly practices. Emotional design also intersected with cultural and contextual elements, fostering user attachment while promoting sustainable values. The findings indicate that these dimensions are not isolated but deeply interconnected, reflecting a holistic perspective on contemporary design trends. This interconnectedness highlights the importance of balancing innovation, technological integration, and sustainability in shaping future design practices.

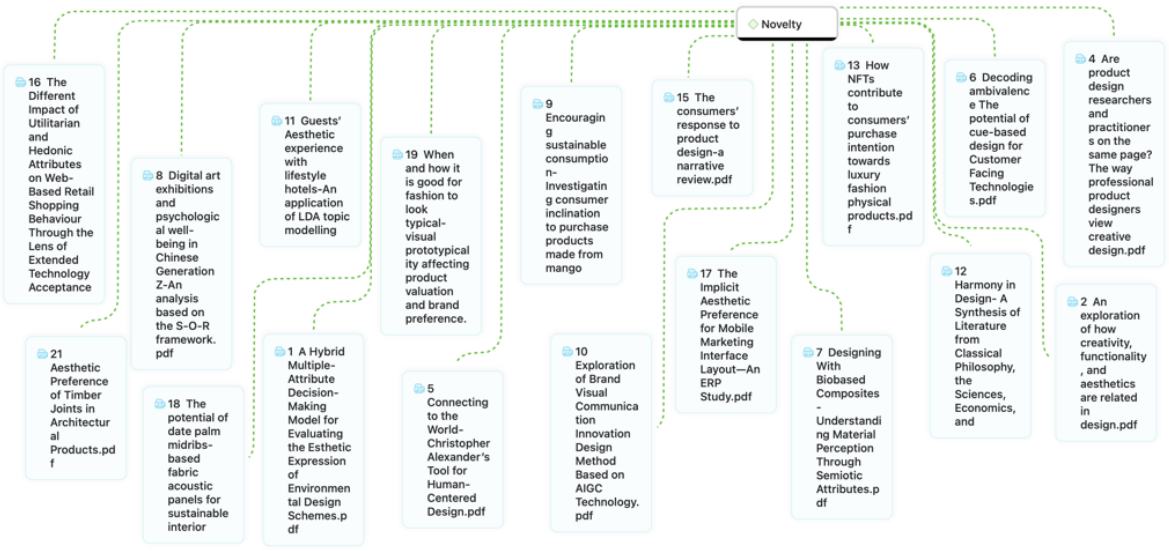

Figure 4. Atlas.ti Analysis of Novelty in Qualitative Data

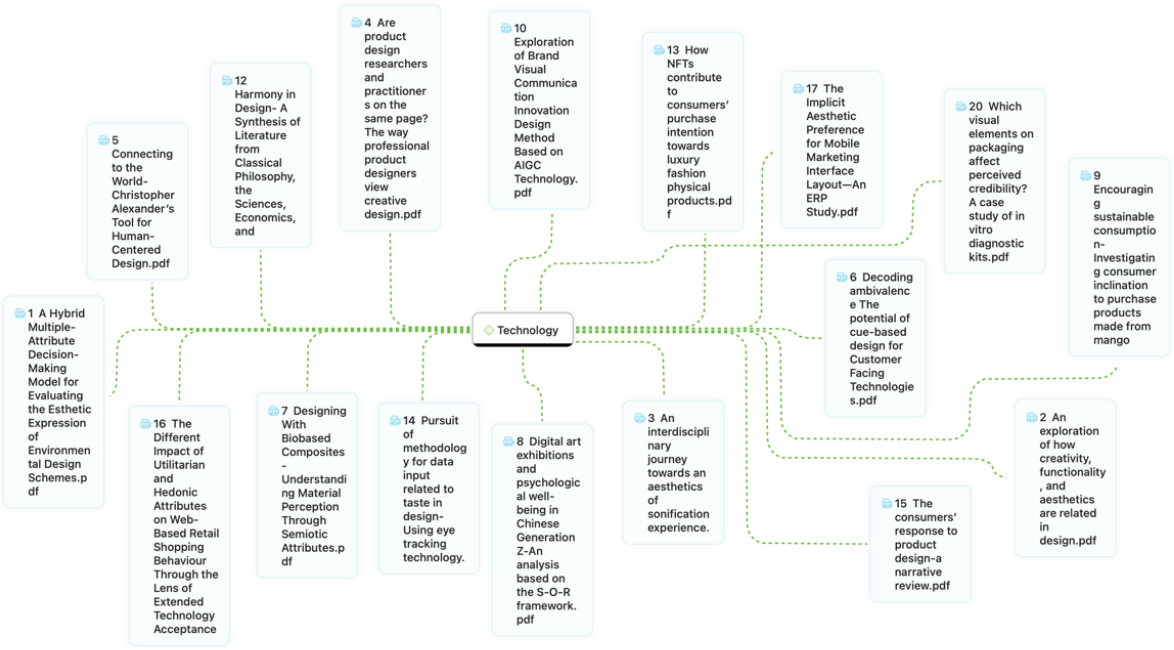

Figure 5. Atlas.ti Analysis of Technology in Qualitative Data

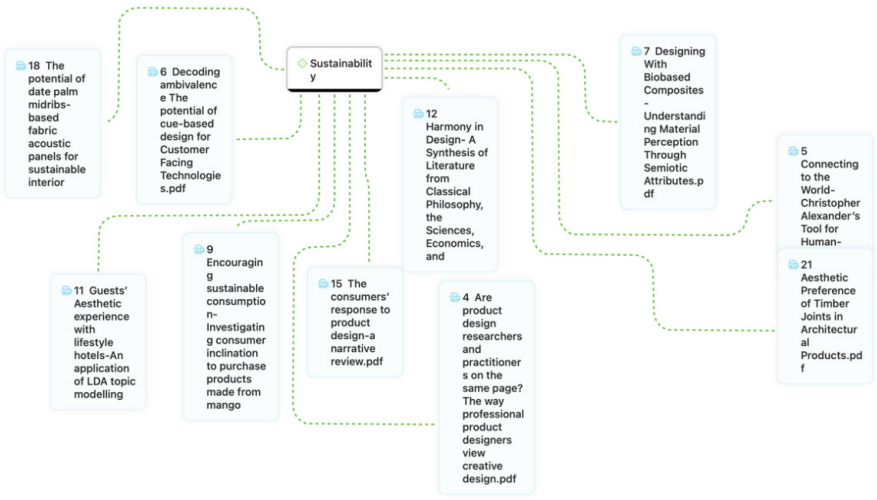

Figure 6. Atlas.ti Analysis of Sustainable in Qualitative Data

Table 3. Dimensions and Thematic Evolution Across Emerging Design Trends

Dimension	Design Trends 1	Design Trends 2	Design Trends 3	Design Trends 4	Design Trends 5
Novelty	Innovation and Uniqueness	Emotional & Experiential Design	Sustainability	Technology and Smart Aesthetics	Cultural & Contextual Integration
Technology	Technology-Driven Decision Models	Technology & Sensory Experience	Technology-Assisted Innovative Design	Technology and User Behaviour	Technology & Sustainability
Sustainability	Form & Proportion	Color & Materiality	Harmony & Unity	Symbolism & Culture	Emotion & Interaction

Novelty in design is a key focus in modern research, showing clear patterns across regions and industries (Table 4). Innovation and uniqueness emphasize originality, with Japan, China, and Australia leading efforts to integrate advanced concepts into design. Documents like Pleyers (2024), Ying (2024) and Zhang and Phang (2024) highlight their role in driving innovation. Emotional and experiential design prioritizes emotional connections and user satisfaction, especially in South Korea and China, where cultural context strongly shapes preferences. Sustainability has become a global focus, with Thailand, New Zealand, Egypt, and Australia adopting eco-friendly design approaches across industries. Technology and smart aesthetics combine advanced technology with functionality, notably in Japan, the USA, China, and Australia, merging innovation with aesthetics. Cultural and contextual integration incorporates local cultural elements, as seen in the USA and the Netherlands, adding social relevance to designs. These trends often overlap, such as technology blending with sustainability and emotional design. Japan and China emerge as leaders, while sustainability and cultural integration reflect global shifts toward inclusive, impactful design.

Table 4. Geographic Distribution and Document Sources for Novelty

Novelty	Rreference	Geographic Location
Innovation and Uniqueness	(Pleyers, 2024; Reiners et al., 2024; S. Wang et al., 2021; Ying, 2024)	Japan, China, Australia
Emotional and Experiential Design	(Lee, 2024; S. Wang et al., 2021; Ying, 2024)	South Korea, China
Sustainability	(Darwish & Midani, 2023; Kuys & Mridha, 2024a; Maitree et al., 2024; Manu et al., 2022)	Thailand, New Zealand, Egypt, Australia
Technology and Smart Aesthetics	(Pleyers, 2024; Reiners et al., 2024; Salingaros, 2020; Wang et al., 2021)	Japan, USA, China, Australia
Cultural and Contextual Integration	(Han et al., 2021; Lomas & Xue, 2022; Salingaros, 2020)	USA, UK, the Netherlands

Technology is increasingly influencing aesthetic design across industries, showing clear global patterns and trends (Table 5). Technology-driven decision models are widely used in the USA, China, and Australia to optimize design strategies with data and algorithms. Technology and sensory experience enhance user interaction, led by Turkey, Portugal, and China, focusing on immersive and interactive designs. Technology-assisted innovative design fosters creativity, with China and Australia leveraging advanced tools for unique solutions. Technology and user behaviour focus on user-cantered designs, utilizing behavioural insights in Thailand, Japan, and China. Technology and sustainability integrate eco-friendly practices, evident in New Zealand, the UK, and China. These trends highlight a global shift toward innovative, user-focused, and sustainable designs, with China emerging as a leader in multiple areas.

Table 5. Geographic Distribution and Document Sources for Technology

Technology	Rreference	Geographic Location
Technology-Driven Decision Models	(Reiners et al., 2024; Taufique, 2024; Zhu et al., 2022)	USA, China, Australia

Technology and Sensory Experience	(Ilhan & Togay, 2023; Seiça et al., 2023; Xia et al., 2024)	Turkey, Portugal, China
Technology-Assisted Innovative Design	(Chen et al., 2024; Sameti et al., 2022; L. Zhang & Phang, 2024)	China, Australia
Technology and User behaviour	(Benaissa & Kobayashi, 2023; Maitree et al., 2024; S. Wang et al., 2021)	Thailand, Japan, China
Technology and Sustainability	(Han et al., 2021; Manu et al., 2022; Yuan et al., 2023)	New Zealand, UK, China

Sustainability in aesthetic design shows distinct patterns and trends across industries and regions(Table 4). Form and proportion emphasize balanced and efficient designs to minimize waste, a trend particularly evident in Australia. Colour and materiality focus on using natural tones and renewable materials, seen prominently in Japan and Egypt. Harmony and unity reflect cohesive and balanced design principles, with China integrating these into sustainable aesthetics. Symbolism and culture incorporate cultural elements into designs, as demonstrated in China, where traditional narratives blend with sustainability to add depth and meaning. Emotion and interaction aim to create emotional connections and meaningful user experiences, a trend spanning China, Japan, and Australia. Overall, sustainability in design emphasizes harmony, material efficiency, cultural integration, and user engagement, with China, Japan, and Australia leading efforts to align functionality and aesthetics with sustainability goals.

Table 6. Geographic Distribution and Document Sources for Sustainability

Sustainability	**Rreference**	**Geographic Location**
Form & Proportion	(Kuys & Mridha, 2024b)	Australia
Colour & Materiality	(Darwish & Midani, 2023; Manu et al., 2022)	Japan, Egypt
Harmony & Unity	(Lomas & Xue, 2022; Salingaros, 2020)	China
Symbolism & Culture	(Ying, 2024)	China
Emotion & Interaction	(Benaissa & Kobayashi, 2023; Maitree et al., 2024; Reiners et al., 2024)	China, Japan, Australia

Based on the data, it is evident that novelty, technology, and sustainability represent the three core dimensions driving contemporary aesthetic design. These dimensions exhibit notable regional variations across the globe while also showcasing multidimensional integration. Novelty-focused design primarily emphasizes technology-driven innovation and uniqueness, emotional and experiential design, smart aesthetics, and cultural-contextual integration. These trends manifest distinct regional characteristics; for instance, designs in Japan, China, and Australia prioritize the integration of technology and innovation, while South Korea and China emphasize emotional and experiential expressions. In contrast, Western countries such as the United States, the United Kingdom, and the Netherlands focus more on cultural contextualization. Overall, novelty-driven design achieves a balance between globalization and localization by incorporating user experiences and cultural contexts. Technology, as a critical force for driving design innovation, is transforming the design ecosystem through multidimensional collaboration. From technology-driven decision models to enhanced

sensory experiences, technology-assisted innovative design, and user behaviour optimization, the interaction between technology and design has grown increasingly interconnected. For example, the United States, China, and Australia employ technology-based decision models to guide design, whereas Turkey and Portugal focus on leveraging technology to enhance sensory experiences. Moreover, the integration of technology with sustainability has gained traction in regions like China, the United Kingdom, and New Zealand, further expanding the ecological pathways in design. This trend underscores that technology not only fulfils functional needs but is also becoming a pivotal driver in enhancing social and environmental values. The practice of sustainable design extends beyond environmental protection to encompass aesthetic proportions, material selection, cultural symbolism, and emotional balance. For instance, Australia excels in the application of form and proportion in design, while Japan and Egypt are recognized for their focus on eco-friendly materials and colour use. China's exploration of harmony, unity, and cultural symbolism is particularly noteworthy, demonstrating the potential of integrating traditional heritage with modern design. Additionally, emotional and interactive design is increasingly emerging as a vital component of sustainable design, enhancing users' psychological satisfaction and emotional attachment in an eco-friendly manner. Overall, the three dimensions—novelty, technology, and sustainability—exhibit overlapping and integrated trends in design. First, the synergy between intelligent technologies and ecological approaches is becoming a significant direction, with the fusion of technology and sustainability offering solutions to global environmental challenges. Second, user-centerer emotional and experiential design spans across all dimensions, leveraging technological tools to achieve personalized and interactive outcomes. Lastly, through cultural reinvention, design is reinterpreting traditional heritage via modern media and aesthetic methods, simultaneously fostering the preservation of cultural identity and catering to the aesthetic preferences of younger generations.

Regionally, East Asia (Japan, China, and South Korea) excels in technology-driven and culturally integrated design, while Western countries (such as the United States, the United Kingdom, and the Netherlands) emphasize cultural and social contextualization. Meanwhile, Australia and New Zealand lead in combining ecological consciousness with formal aesthetics. These variations highlight the dynamic balance between globalization and localization as a critical feature of future design trends. Looking ahead, aesthetic design will place greater emphasis on interdisciplinary innovation, integrating knowledge from technology, psychology, and ecology to advance green design and cultural reinvention. Furthermore, the fusion of technology and emotion will continue to deepen, employing intelligent solutions to enhance emotional connections between users and products, thereby advancing the role of design in fulfilling social and ecological responsibilities.

5.2 Integration Framework and Guiding Principles

Building upon the findings from Sub RQ1, "What are the patterns and trends in emerging aesthetic design features focusing on novelty, technology, and sustainability in products across various regions?", this study proposes a framework based on these patterns to address Sub RQ2: "What principles can be identified from emerging aesthetic trends in product design to guide the development of a framework integrating novelty, technology, and sustainability across different regions?" The framework is structured around three main dimensions—Novelty, Technology, and Sustainability—and identifies five guiding principles: Localized Innovation, Technology Synergy, Sustainable Aesthetics, Emotion-Driven Design, and Cultural Adaptability. First, novelty is essential in capturing users' attention and interest. It reflects trends such as innovation and unique-

ness and emotional and experiential design (Table 3). These trends highlight the need for a balance between introducing fresh ideas and maintaining familiarity. Incorporating regional cultural elements into design can further enhance emotional appeal and user engagement. Second, technology plays a key role in enabling more effective and interactive designs, as seen in trends like technology-driven decision models and technology and user interaction. By using technology, designers can create more functional and adaptable products that respond to diverse needs. Third, sustainability emphasizes the integration of environmental responsibility into aesthetic considerations, represented by trends such as form and proportion and emotion and interaction. This involves selecting sustainable materials and adopting design practices that reduce environmental impact while ensuring aesthetic quality. At the centre of this framework is the Framework Core, where the three dimensions—novelty, technology, and sustainability—intersect. This core represents the combined influence of these dimensions, which forms the foundation for a cohesive approach to design. For instance, trends like cultural and contextual integration allow designs to adapt to regional preferences, making them more relevant and accepted across different settings. Similarly, emotion-driven design strengthens the connection between users and products by creating meaningful experiences and fostering a sense of attachment. This framework provides clear guidance for design practices. During the initial analysis phase, designers should assess how novelty, technology, and sustainability are prioritized by their target audience. In the design phase, decisions about materials, functionality, and cultural context should align with the identified principles. Finally, during the review phase, designs should be refined based on feedback to ensure they remain relevant and effective in different contexts. This framework offers a practical way to integrate emerging design trends, helping designers create products that balance aesthetic appeal, functional innovation, and environmental awareness, while also addressing cultural diversity in a globalized context.

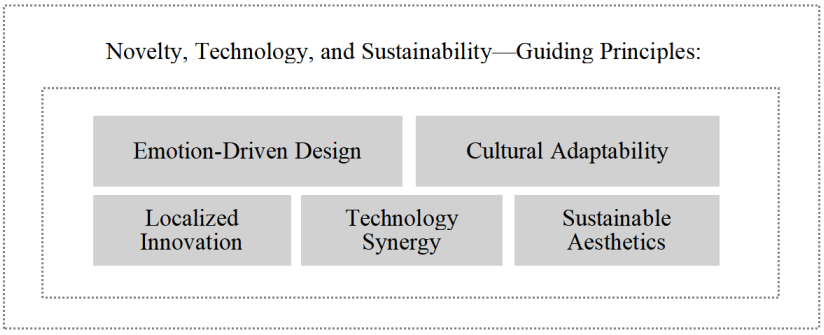

Figure 4. Novelty, Technology, and Sustainability—guiding principles.

6 Conclusion

This study explores the research question: "How can product designers effectively integrate aesthetics, technology, and sustainability to create innovative products that align with evolving consumer preferences across various industries?" By examining emerging design trends and developing a framework, the study offers practical guidance for addressing this challenge. The findings identify novelty, technology, and sustainability as the three core dimensions shaping contemporary product design. These dimensions vary across regions, reflecting global and local influences. For instance, novelty-driven design often combines technology and cultural elements to create unique and emotionally engaging products. This approach is prominent

in regions like Japan and China, where innovation and emotional expression are prioritized. Technology plays a critical role in modern design, enabling enhanced functionality and interaction through data-driven decision-making and sensory features. Countries such as the United States and China demonstrate leadership in this area. Sustainability extends beyond environmental responsibility to include material innovation, aesthetic harmony, and emotional balance, as seen in Australia, Japan, and other regions. Together, these trends emphasize a balance between innovation, cultural relevance, and environmental awareness. Building on these insights, the study proposes a framework to guide designers in integrating these three dimensions effectively. The framework introduces five key principles—Localized Innovation, Technology Synergy, Sustainable Aesthetics, Emotion-Driven Design, and Cultural Adaptability. These principles provide a structured approach for creating designs that resonate with users while addressing functional and environmental needs. At the core of the framework lies the integration of global and local influences, enabling designs to remain relevant across diverse markets. The framework supports designers through three stages: analysis, where user and market needs are identified; design, where materials, functionality, and cultural elements are integrated; and evaluation, where feedback ensures continuous improvement. This approach helps balance aesthetic appeal, technological innovation, and sustainability, ensuring designs meet consumer expectations and broader societal goals. This study highlights the importance of integrating aesthetics, technology, and sustainability in response to changing consumer preferences. Looking forward, interdisciplinary approaches that combine knowledge from design, technology, psychology, and ecology will become increasingly important. By addressing both cultural diversity and environmental challenges, designers can create products that are not only functional and innovative but also meaningful and responsible.

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