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Color, Material, and Finish (CMF) Design Innovation and Cultural Integration: Exploring Smart Digital Gadgets Differentiated Design

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Abstract

This study explores the cultural and emotional factors in the design of Smart Digital Gadgets (SDGs), particularly focusing on the application of CMF (Color, Material, and Finish) design. Despite the rapid technological advancements in SDGs in the digital era, there is a prevalent issue of design homogenization, leading to a lack of emotional and cultural connection with users. Through a literature review, this study identifies the current problems in SDGs design and proposes a new framework that integrates cultural design and CMF design to enhance user experience and product differentiation. Using Ibrahim's unique “Literature Review Synthesis Process” method, 26 relevant articles were selected and analyzed from Scopus and Google Scholar, resulting in the identification of three main themes: Smart Digital Gadgets Design, CMF Design and Research Methods, and Cultural Feature Design and Application. The findings suggest that integrating cultural dimensions into CMF design can enhance the visual design theoretical framework of SDGs and promote cultural inheritance. This study provides guidance for future SDGs design practices and academic research, emphasizing the importance of cultural and emotional design in meeting consumer needs. Future research will continue to explore the integration of cultural dimensions and emotional design methods in CMF design.

Keywords: Smart Digital Gadgets, CMF Design, Cultural Dimension, Emotional Design, User Experience

Introduction

In the digital age, smart digital devices have become an integral part of daily life. According to IDC's "Global Personal Computing Device Quarterly Tracker Report" the shipment volume of tablets is expected to reach 135 million units in 2023, with smartphone shipments reaching 1.1516 billion units, totaling 1.294 billion units. <Tech Insights> predicts that the tablet market

will rebound in 2024, and the smartphone industry is also steadily recovering. According to Statista's data, the global smartphone users will exceed 3 billion by 2023, with a smartphone penetration rate exceeding 70%. Tablet sales continue to grow, especially among students, business professionals, and households. Smart digital devices have not only changed the way people communicate but also had a profound impact on work, entertainment, and socializing. Over the past decade, the industry has experienced exponential growth due to the integration of advanced technologies such as artificial intelligence, machine learning, and the Internet of Things. This article aims to study the current status and challenges of the smart digital gadgets (SDGs) design industry, explore its development history, cultural influences, technological innovations, and future trends. SDGs are not only technological products but also products of social culture. Their design is influenced by geography, culture, and user needs, driving technological progress. Designers need to break the homogenization of design, create attractive and ergonomically designed products, ensure personalized and cultural attributes of the design, keep up with the latest trends and innovations, and maintain competitiveness. With technological evolution and changes in user behavior, the SDGs industry will face more challenges and opportunities. This article aims to fill research gaps and provide insights for future device design and development.

Research Methodology

This literature review follows the unique "Literature Review Synthesis Process," which was proposed by Ibrahim and Mustafa Kamal in 2018. This method belongs to the category of independent literature review typology. This study adopts Ibrahim's Research Question Classification (RQC) technique Ibrahim (2008, 2011) to determine research topics, which helps identify three different RQ structures when constructing main research questions, namely "WHO," "WHAT," and "HOW." Ibrahim defines the "WHO" structure as the elements used or influenced by the research, the "WHAT" structure as the information needed to address the research questions, and the "HOW" structure as the information regarding actions or influences on the elements studied. This study reviews the current development and trends in SDGs design, while also delving into related research on cultural attributes and CMF design.

This report focuses on exploring the development and trends of visual design for smart digital gadgets under the RQ structure. To ensure the accuracy and authority of the research, we utilized Scopus and Google Scholar as literature search tools and applied keywords closely related to the RQ structure, such as "Smart digital gadgets," "smart devices," "smart digital gadgets CMF design," "smart digital gadgets culture design," and "smart digital gadgets trend," to conduct in-depth screening of journal articles from 2004 to the present. After rigorous screening for relevance to the theme of "smart digital gadgets culture-led CMF design," we initially selected 83 papers. Subsequently, based on the three sub-themes of the literature review article structure： (1) Background knowledge of Smart Digital Gadgets Design, (2) CMF Design and Research Methods, and (3) Cultural Feature Design and Application—we further narrowed down to 32 highly relevant articles. For each sub-theme, this report elaborates on the main works and viewpoints of previous authors, analyzes how these viewpoints support future research, and identifies areas needing further enhancement. Additionally, we generated comprehensive conclusions for each sub-theme and, through further cross-analysis, integrated possibilities and prioritized the analysis information to identify effective solutions to improve the homogenization problem in SDGs design. Finally, building upon the "POD (Point of Departure) Tree" proposed by Ibrahim and Mustafa Kamal

(2018), this report presents key conclusion predictions. Furthermore, we delve into the trends and solutions for future CMF design of smart digital terminal devices, aiming to provide valuable references for research and practice in relevant fields.

Results

Background knowledge of Smart Digital Gadgets Design

In the 1970s and 1980s, personal computers emerged as the first wave of smart digital devices. However, it wasn't until the late 1990s that smart digital devices entered a new stage with the development of the internet and mobile communication. In 2007, Apple introduced the iPhone, marking the beginning of the popularization of smartphones. Its intuitive interface, rich applications, and multifunctionality changed people's lifestyles, becoming a comprehensive platform for information retrieval, entertainment, and social interaction. In addition, the introduction of tablet computers was also a significant milestone in the field of smart digital devices. Their slim and portable design, touchscreen operation, and rich applications changed people's usage habits of traditional computers, driving the development of the mobile internet era.

However, in terms of the appearance design of digital smart products, it has failed to keep up with the pace of technological development. While modern and minimalist design styles have their advantages in universality, excessive use can lead to products lacking emotional appeal and humanistic care. The phenomenon of design homogenization is severe, limiting designers' innovation space and impeding progress in the entire industry. Dou et al (2021) argues that with the shift in consumer consumption attitudes and the homogenization of functionalities, the impact of product appearance design, customer characteristics, and emotional factors on consumer purchasing decisions is becoming increasingly significant. Therefore, good user experience and satisfaction are particularly important in the smart digital device industry. Sääksjärvi et al (2014) conducted intercept surveys of mobile phone users in Beijing and Shanghai. They suggested that improvements in smart phone functionality design have increased customer satisfaction, while aesthetic aspects such as color and device thickness positively influence consumers' frequency of upgrading their phones. Sonderegger & Sauer (2010) proposed that an attractive product appearance can enhance perceived usability and also has a positive impact on product performance. However, the influence of usability on perceived attractiveness is minimal, and adolescents are more concerned with the aesthetic experience of mobile phones.

In this regard, writers and designers have also put forward their own views on solving the homogenization of design, and design needs to meet the personalized and emotional needs of consumers. Kim et al.(2010) proposed that mobile phone design should not only consider technical satisfaction, but also emotional needs. Emphasized that emotional needs are influenced by product appearance and performance. YAO et al (2021) proposed that more emotional design elements should be integrated into mobile interaction design at the same time, emphasizing that emotional design will also become the main development trend of interaction design. Starting from user experience, Chen (2018) proposed six elements of product user experience: functional needs, sensory needs, interactive needs, emotional needs, social needs, and self needs. Emphasizing that experience design has become a new trend in brand product competition. Zhang (2021) proposed that emotional design in product design is based on the psychological, emotional, and daily needs of consumers, adhering to the design goal of "putting people at the center".

Emphasizing emotional design is the trend. Therefore, the design of intelligent digital devices should constantly innovate to adapt to these changes.
However, Sonderegger et al.'s research experiments may have certain uncertainties, such as the confounding effects of familiarity with a product and aesthetic preferences. In affective cognition, people's purchasing decisions often rely on familiarity and aesthetics. Sääksjärvi et al. did not further investigate the relationship between mobile phone design elements and perceived aesthetic fatigue. Kim et al.'s research on emotional design primarily evaluates emotional vocabulary in two dimensions: the appearance and performance of mobile phones. Dou et al. conducted customer satisfaction analysis for product hardware design through Kansei requirements, constructing a satisfaction model. Zhang's study primarily reflects on product design patterns at the reflective level, with instinctual and behavioral aspects as secondary considerations. None of these theoretical models provide a refined analysis and evaluation specifically focused on aesthetic design.
Overall, in today's pursuit of innovation and personalization, integrating consumers' emotional needs and personalized requirements into design has become crucial for driving design progress. Therefore, my research will delve into understanding consumers' psychological and emotional needs, conducting refined analysis through the CMF (Color, Material, Finish) design system, and translating these needs into specific design elements and features. In the design of smart digital gadgets, visual elements such as color, material, and surface treatment are utilized to convey different emotions and information, thereby attracting and satisfying consumers' personalized needs.

CMF Design and Research Methods

The continuous progress of intelligent technology has revolutionized the way smart digital gadgets interact with humans, thereby changing people's way of life. In the increasingly developed era of electronic information, CMF design has become an important method for mobile phone and tablet styling design. Throughout the development process of smart digital gadget styling, the combination of technology and art is the inexhaustible driving force behind the evolution of theirs styling.
Currently, although there is no clear system for CMF design in SDGs, it possesses a complex interdisciplinary background. However, CMF design embodies the future diversification of design and market competitiveness. Chen et al (2019) argue that CMF holds high research value and significant innovation potential in the current design industry. They believe that transforming color, material, and surface decoration into design elements can create higher product value, provide consumers with more satisfying user experiences, and enhance the product's market competitiveness. Zuo (2020) discusses various functions of CMF such as identification, self-cleaning, sound absorption, color change, luminescence, antibacterial properties, breathability, magnetism, and biomedical applications, emphasizing that multifunctional combinations of CMF can bring about significant effects with less effort. They emphasize the organic matching of CMF functionality and aesthetics, which can effectively enhance the overall attractiveness and market competitiveness of design objectives. Gao & Zhang (2020) argue that CMF is crucial in mobile phone design. They emphasize that material selection and process application directly impact user experience, and CMF is leading design towards diversification and personalization. Wang et al (2020) propose that product serialization design better reflects brand style and has stronger vitality and market competitiveness. Therefore, users are no longer satisfied with standardized, homogenized

products, and personalized customization has become an important means of product differentiation competition.

CMF design not only promotes the development of emotional design in smart digital gadgets but also enhances user experience satisfaction. Based on the diversified development of CMF design for intelligent digital products and emotional design, designers and scholars have proposed various research methods. Zhao et al (2014) proposed a design approach based on user mental models, presenting the psychological activities of designers when querying and selecting materials, making the functionality of CMF network databases more aligned with user needs. Jia (2018) approaches CMF design from the perspective of ecological psychology, providing a new perspective for comprehensive analysis of consumer needs and targeted design. They emphasize the attention to conveying information through color, material, and texture and its interaction with users from different backgrounds. Wang et al (2020) utilize "CMF image maps and color scheme diagrams" as mediums for transferring user emotional information, completing the emotional design method of CMF for products, making the perceived demands of CMF for products more visual. Hao (2020) summarizes nineteen design elements and nine development processes of product configurators from the perspective of user experience. Chen (2019) analyzes mobile phone color schemes and CMF design cases and their color design and emotional elements using semantic analysis methods from color psychology. The introduction of these research methods undoubtedly provides more diversified and refined design ideas for CMF design of SDGs. Designers are beginning to pay more attention to users' psychological needs and the impact of CMF elements such as color, material, and texture on user experience. Therefore, CMF design driving can address emotional design and, at the same time, deepen the design of sensory intentions driven by CMF under information technology and the diversity of future CMF design research (Fu et al., 2022).

CMF design for SDGs is an important means to enhance product value, improve user experience, and strengthen market competitiveness. Designers are focusing on user psychological needs and the impact of CMF elements on experience through diversified and refined design approaches, promoting CMF design towards emotional and personalized directions. With the advancement of technology and changes in consumer preferences, CMF design will continue to be a core area of innovation in intelligent product design.

Cultural Feature Design and Application

CMF design plays an increasingly important role in modern product design, serving not only as a technical means but also as a cultural expression. Kim (2015) suggests that culture influences individuals' preferences for product colors. It emphasizes that changes in a person's cultural background can lead to changes in their preferences for smartphone colors. Zuo (2018) proposes three levels of innovation in cultural experiences through CMF: macro, medium, and micro. It emphasizes the recognition of characteristics of "big culture" or "local culture" and "corporate culture," allowing products to meet users' cultural experiences. Zhu et al (2018) studied the application of ceramics in CMF design for smartphones, believing that ceramics can effectively enhance product appearance, performance, and design efficiency. It emphasizes that product cultural, uniqueness, and aesthetic form will become the focus of each segmented user group. Ugale et al (2022) extracted CMF elements from traditional Maharashtrian craft and transformed them into design elements for bowls, confirming the feasibility of a culture-oriented approach for CMF design and the significant impact of cultural connotations on product identification. Kuang & Li (2020) proposed researching color,

material, processing technology, and patterns of products within the framework of CMF design to express traditional cultural contexts. It emphasizes that new design perspectives can make products more in line with modern aesthetic and lifestyle needs, promoting the inheritance and innovative development of Chinese traditional culture. Hu et al (2020) proposed a user-centered research approach using design thinking, clustering users from the bottom up, and utilizing CMF design to meet users' current habits of aesthetic experience and scene consumption. This method provides an effective channel for changing product design through design to meet consumers' behavioral habits. Therefore, designers and scholars, considering consumers' behavioral habits, utilize color, material, and surface craftsmanship to complete CMF design for products. This not only enhances the usability of products but also highlights the spiritual and symbolic functions of culture and brand in products.

However, Kim's research on the relationship between color and culture in South Korea and Japan primarily considers individual cultural backgrounds, lacking guidance for diverse cultural designs. Zuo analyze CMF designs from specific cultural dimensions. Although these studies mention the influence of culture, they often focus on research within specific cultures or regions, which may limit the universality of their results. Therefore, my research needs to consider the exchange and integration of different cultures more broadly to comprehensively understand the influence of culture on product preferences. Moreover, while these studies all involve innovation in CMF design from a cultural perspective, their methodologies are not entirely consistent. Zuo's research emphasizes levels from macro to micro, while Ugale et al. focus more on integrating traditional cultural elements. Thus, there is a lack of a unified theoretical framework to guide related research. Additionally, there is relatively little practical application validation for these theories and methods. The lack of sufficient validation of the effectiveness and feasibility of these theories and methods in actual product design may affect their practical application outcomes.

Overall, this study aligns with the views of Hu et al., indicating that CMF design, as a bridge between products and users, is gradually demonstrating its indispensable value. From individual preferences for smartphone colors to CMF elements in traditional crafts, to applications in modern smart homes and wearable devices, CMF design not only influences the appearance of products but also conveys profound cultural connotations. These studies and practices demonstrate that CMF design is not just an innovation at the technological level but also an in-depth exploration of culture, art, and user experience. Therefore, with the advancement of technology and diversification of consumer demands, CMF design will play a unique role in more fields. In future designs, the intersection of CMF and cultural design will generate more innovative designs, bringing consumers more aesthetically pleasing and culturally rich products.

Discussions

The article analyzes the development characteristics of CMF design for SDGs' aesthetics, combined with the evolution process of research methods and cultural dimensions of CMF. It concludes that developing culture-oriented CMF design models for SDGs is feasible.

The Relationship between Emotional Experience and Functionality in CMF Design

In the information age, the forms of intelligent products tend to homogenize, making CMF design a key symbol of brand recognition and user experience. CMF design is not merely a form of visual art; it also reflects users' emotional experiences and product functionality. Additionally, CMF can visualize and concretize abstract meanings, establishing symbol

systems that align with user cognition. In modern design practice, CMF design has become a multidimensional concept, requiring designers to not only have good aesthetic abilities but also deep knowledge of materials and processing techniques. Designers need to seamlessly integrate the functionality and aesthetics of products through CMF design, creating products that are both practical and attractive.

The CMF design of Smart Digital Gadgets is a complex and multifaceted process, requiring designers to consider various factors such as color, materials, surface treatment techniques, user experience, sustainability, and technological integration. Through innovative and sensitive design thinking, designers can create CMF designs that are both aesthetically pleasing and meaningful, thereby strengthening the brand influence and cultural value of Smart Digital Gadgets, enhancing user experience, and driving sustainable brand development. Therefore, CMF design is not merely about beautifying product appearance; it is a form of deep-seated emotional communication. Through the skillful application of color, materials, and surface treatment techniques, CMF design establishes emotional connections between products and users.

Relationship between SDGs and Cultural Design

The acceptance of CMF design varies significantly across different cultural backgrounds, mainly due to differences in the perception and preferences of colors, materials, and surface treatment techniques among different cultures. When designers conduct CMF design, they need to consider the cultural background of the target market to ensure that the designed products are accepted and appreciated by local consumers. Therefore, the differences in acceptance of CMF design across different cultural backgrounds require designers to adopt flexible and sensitive design strategies. By understanding localized design and cultural values, researching cultural differences, conducting user studies, providing customization options, leveraging the symbolic meaning of colors, selecting appropriate materials, employing surface treatment techniques, maintaining consistency in design elements, storytelling for the brand, balancing innovation with tradition, promoting consumer participation, and conducting education and communication, designers can create CMF designs that are both aesthetically pleasing and meaningful. This reinforces the brand story and cultural value of the product, creating SDGs designs that are both globally appealing and respectful and integrated into local cultures.

POD (Point of Departure) Tree Diagram

The POD (Point of Departure) tree diagram is obtained through a theoretical framework (Ibrahim & Mustafa, 2018). This section discusses how the literature review further derives synthesized initial results to formulate final potential theoretical propositions, providing research directions for the future (Figure 1).

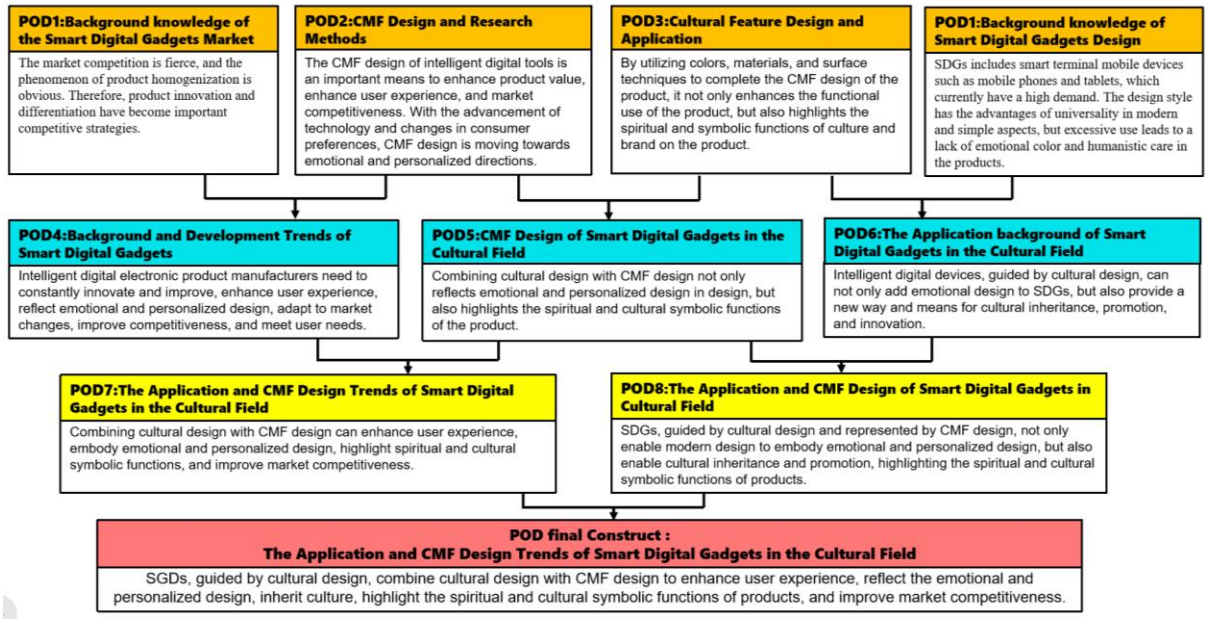

Figure 1. Point of Departure (POD) Tree Diagram of the promoting effect of cultural design and CMF design on SDGs. (Adapted from Ibrahim and Kamal, 2018).

Conclusion of Section 3.1 emphasizes POD1: Smart Digital Gadgets, particularly mobile devices, are currently in high demand, with their design style characterized by modernity and simplicity, which has its universal advantages. However, overuse of this style leads to products lacking emotional colors and humanistic care. Simultaneously, fierce market competition and noticeable product homogenization call for innovation and differentiation as crucial competitive strategies. Section 3.2 reflects the conclusion of POD2: CMF design for SDGs is a vital means to enhance product value, improve user experience, and strengthen market competitiveness. As technology advances and consumer preferences evolve, CMF design is shifting towards emotional and personalized directions. The conclusion of Section 3.3 represents POD3: By utilizing color, materials, and surface treatment techniques in CMF design, products can not only enhance their functional usability but also highlight the spiritual and cultural symbolic functions attributed to the brand. The first-level PODs, namely POD1, POD2, and POD3, summarize the conclusions after the literature review.

The second-level PODs, namely POD4, POD5, and POD6, are results derived from the combination and analysis of the first-level PODs. Analyzing the results of POD1 and POD2 leads to the conclusion of POD4: Manufacturers of smart digital electronic products need continuous innovation and improvement to enhance user experience, reflect emotional and personalized designs, adapt to market changes, increase competitiveness, and meet user needs. POD5, derived from the comprehensive analysis of POD2 and POD3, indicates that combining cultural design with CMF design not only reflects emotional and personalized designs but also highlights the spiritual and cultural symbolic functions of the products. POD6 is a deduction from the content of POD1 and POD3, indicating that smart digital devices, guided by cultural design, not only add emotional design to SDGs but also provide a new approach and means for the inheritance, promotion, and innovation of culture.

The third level includes POD7 and POD8. This study analyzes the content of POD4 and POD5, proposing POD7 regarding market-related key information: combining cultural design with CMF design can enhance user experience, reflect emotional and personalized designs, highlight spiritual and cultural symbolic functions, and improve market competitiveness.

Combining POD5 and POD6, POD8 summarizes key information regarding design applications, showing that SDGs, guided by cultural design and expressed through CMF design, not only enable modern design to reflect emotional and personalized designs but also enable cultural inheritance and promotion, highlighting the spiritual and cultural symbolic functions of the products.
Finally, the fourth level combines POD7 and POD8 to obtain the final POD construct. SDGs, guided by cultural design and combining cultural design with CMF design, can enhance user experience, reflect emotional and personalized designs, inherit culture, highlight the spiritual and cultural symbolic functions of products, and improve market competitiveness. Figure 2 is a conceptual framework illustrating how the integration of personalized and emotional CMF design with cultural dimensions into SGDs design can enhance the visual design theoretical system of smart digital gadgets, promote cultural inheritance, and reflect cultural values (Figure 2).

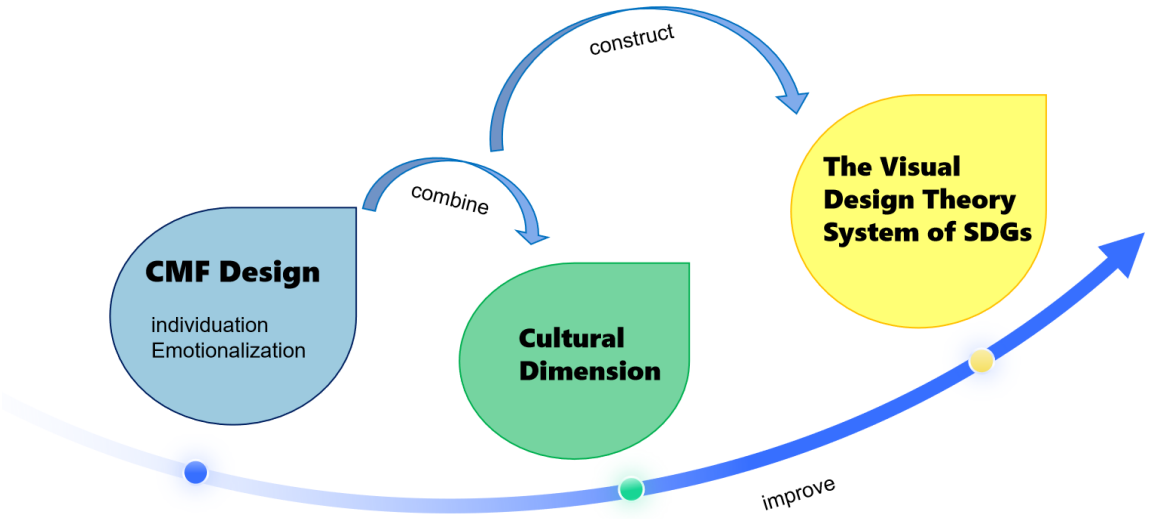

Figure 2. Improve the visual design theoretical framework of SDGs

Conclusions

This paper reviews and analyzes 26 articles on visual design issues related to the SDGs from 2004 to 2024. It was found that the influence of cultural factors on CMF design is significant and cannot be ignored. Emotional and personalized design elements are key to meeting consumer needs and enhancing user experience. Furthermore, combining cultural design with CMF design, by highlighting the spiritual and cultural symbolic functions of products, not only enhances user experience but also increases the market competitiveness of the SDGs. CMF design of Smart Digital Gadgets (SDGs) plays a crucial role in the current digital era. It not only concerns the appearance and tactile sensation of products but also profoundly influences their functionality, environmental friendliness, and emotional connection with users. With the rapid development of technology, especially the integration of artificial intelligence, machine learning, and Internet of Things technologies, the application of CMF design has become more extensive and profound. Designers are required to keep pace with technological trends and utilize new technologies to enhance design quality. Additionally, the impact of cultural factors on CMF design cannot be ignored. Designers must consider the

preferences and needs of consumers from different cultural backgrounds to ensure that products can meet the diverse demands of the global market. Furthermore, emotional and personalized design has become key to meeting consumer demands. Designers can convey different emotions and information through visual elements such as color, material, and surface treatment, attracting and satisfying consumers' personalized needs. This study also emphasizes the importance of combining cultural design with CMF design. This combination not only enhances user experience but also highlights the spiritual and cultural symbolic functions of products, thereby enhancing their market competitiveness. Future research needs to continue exploring the application of CMF design in smart digital gadgets, especially in terms of cultural integration, emotional design methods, and the potential of new technologies such as virtual reality, augmented reality, big data, and artificial intelligence in CMF design.

Through these conclusions, this study provides a comprehensive perspective on the visual design of SDGs and offers guidance for future design practices and academic research. With the continuous advancement of technology and the increasingly diverse consumer demands, CMF design will continue to serve as a core area of innovation in smart product design, driving the industry's continuous development and progress.

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