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Innovation design driven by sustainability: A case study based on Samsung electronics

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Abstract. Under the background of sustainable development, the sustainable design and transformation of household appliances are important contents. The aim of this study was to explore the actions and strategies of home appliance companies in sustainable product design. The home appliance products of Samsung Electronics were selected as the main research object, and used case study and strategy research to analyse information and summarised its expressed themes. In the sustainable design of products, a recycling ecosystem centred on home appliances was constructed by Samsung Electronics, and supporting products were developed as key entry point. The exploration of sustainable transformation with corporate characteristics was carried out under the influence of external policy environment, corporate social responsibility, and technological co-innovation. Three major elements of its sustainable design strategy were identified: a design ecology driven by both products and users, the reshaping and optimisation product life cycle management, and user-oriented inclusive design. These elements were shown to provide new insights into the direction of future research and practice. The global transition toward greener home appliance production highlighted the importance of cooperation among enterprises. Based on Samsung's practical experience, it can provide designers and design companies with intuitive and feasible learning standards, and help enterprises explore diversified strategies for sustainable development based on their own situations. The practical significance of this study is that its results can serve as recommendations for designers and companies in the field of home appliances, demonstrating how sustainable design strategies can be effectively integrated into product development and user experience

Keywords: sustainable design; home appliances; product design; user-friendly; case analysis

INTRODUCTION

In the context of global sustainable development, the sustainable transformation of home appliances is not only a modern design trend, but also a strategic decision in the perspective of design studies. At the macro level, sustainable design – as a solution to participate in the construction of ecological civilisation – aims to promote the harmonious development of environment, economy and society. At the micro level, as the undertakers and implementer of sustainable responsibility, enterprises need to consider sustainably-driven innovative design in the whole chain production process, review all aspects of the product life cycle, so as to realise

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product upgrading and iteration and lean manufacturing. In this process, product design and innovation are crucial. J. Liu *et al*. (2025) pointed out that the sustainability of a product largely depends on the design stage. H.B. Taramsari *et al*. (2025) believed that the overall sustainable design of a product should revolve around the triple bottom line principles of sustainable design. It is evident that the sustainable design of household appliances is an interdisciplinary and comprehensive study, with in-depth research achievements in environmental, economic and social aspects.

From the perspective of product design, the research hotspots and directions of sustainable design for household appliances are comprehensive. According to X.R. Nie (2024), the development trend of the integration of home environment and household appliances was proposed. It is believed that this method can promote the energy conservation, environmental protection and sustainable healthy development of the industry. The research results of X.Y. Jiang & Q. Wu (2024) indicated that the green transformation of packaging was an important strategic deployment for the sustainable design of home appliances. Z. He *et al*. (2025) also clarified the significance of lightweight design and lean design in their research on the transportation packaging of household appliances. In addition, L. Mei *et al*. (2024), from the perspective of consumers' green purchasing behaviour, pointed out that the energy efficiency information in the design of home appliances has a certain regulatory effect on users' cognition. J.W. Du *et al*. (2019), in response to the green demands of household appliances, have constructed a framework for the green design of household appliances from the aspects of green material development and selection, green design technology, and green evaluation technology. In addition, academic research with the keyword "sustainable design" also focuses on resource utilisation and energy efficiency. W. Liu *et al*. (2025) achieved the management and optimisation of energy systems through multi-agent systems to meet the electricity demands of different household appliances. Meanwhile, the recycling and utilisation of used household appliances have also received certain attention.

Based on the thematic research on Samsung Electronics, in the academic field, Chinese scholars' research on Samsung Electronics mostly focuses on the exploration of the development path of the enterprise. The research of South Korean scholars focuses on the analysis and interpretation of local enterprises (Cha, 2021). Regional differences have led to variations in research levels, resulting in information gaps in this field of study. J. Kim (2022) pointed out in his research on the history and current situation of design in South Korea that the design of Samsung's home appliances has a leading role. Based on the product display of Samsung Home Appliances, L. Su (2024) summarised the core role of intelligent technology in home appliance design, and at the same time pointed out that the integration of home appliances and the home environment is an important trend in product design. In addition, Samsung Electronics is constantly researching and developing materials and processes such as recycled packaging films and surface treatment of aluminium materials, and is continuously making technological innovations in nanotechnology (Mohammed *et al*., 2024), the chip industry, display components, 5G technology and other fields.

From the perspective of the sources of research results, most of the research on sustainable design of household appliances is disseminated within the industry through news and information, etc. There is a lack of theoretical research in this field, opening up opportunities for reflection in professional academic research. At the same time, home appliances themselves should be the focus of research. It is necessary to explore the key role of design thinking and innovative methods in home appliance enterprises. Therefore, the main purpose of this research was exploring typical cases of sustainable development of home appliance enterprises from the perspective of design studies and summarising design direction.

MATERIALS AND METHODS

In order to understand and explore the sustainable design and development strategies of home appliance enterprises, this paper took Samsung Electric as a research sample. Samsung's practice in the field of sustainable design can be considered an industry example, and its product innovation design fully reflected the integration of environmental protection, social responsibility and economic benefits, demonstrating the transformation of ecological brands from traditional home appliance brands to smart home solutions. Through case studies, this paper analysed the product innovation path of Samsung Electronics in the field of sustainable design from 2023 to 2026. The choice of the indicated period was due to the availability and representativeness of empirical data. The scope of this research was defined from the product and user dimensions to specifically explore the sustainable performance of Samsung home appliances in all aspects, including material selection, packaging design, energy-saving technology, user needs, inclusive design, and humanised design. This study adopted a multi-source data collection method. The data sources included the official website of Samsung (Samsung Electronics, n.d.b), product display information, media reports and other channels to collect samples of sustainable design of Samsung home appliances. Using keywords such as "Samsung Home Appliances", "Sustainable design", and "green products" as the core, relevant product models and information were systematically searched and screened. Representative products and strategic actions were selected for further analysis. Their specific performance in sustainable design was interpreted, and sustainable

design strategy with Samsung's characteristics were summarised. Moreover, sustainability-related sections and thematic documents, including corporate social responsibility and sustainability reports, were analysed to assess the accuracy, consistency, and relevance of the collected information.

This study provided insight into its path of sustainable change from three stages. Firstly, starting from the home appliances, Samsung's specific actions were examined and typical cases were selected for analysis. Secondly, from the perspective of user research, the specific manifestations of the sustainable development and transformation of Samsung Home appliances were explored. Finally, Samsung's sustainable development strategy was summarised based on the analysis results and the understanding of sustainable design thinking. The overall research path followed the mapping from product micro-design to development macro-layout, constructing a development theoretical system through product design practice. The limitation of this study lay in its reliance on publicly available product information and relevant materials to summarise the important manifestations of sustainable design in home appliances. It did not include in-depth interviews within enterprises and focused on the analysis of Samsung's home appliance product cases, with the aim of summarising innovative design strategies suitable for the sustainable transformation of enterprises in specific home appliance design cases.

RESULTS AND DISCUSSION

Samsung has built a product ecology around the strategic direction of "sustainability". Samsung Electronics is involved in two major themes in the sustainable design of home appliances. First, focusing on product-centred design optimisation and lean manufacturing of efficient and environmentally friendly home appliances. Secondly, user-centred, accessible and emotional design that pursues social equity.

Product dimensions of sustainable design performance. In the product dimension, building a circular ecology centred on home appliances is an important step for Samsung Electronics on the road to sustainable design. The development and transformation of sustainable design is enhanced and accelerated at a systemic level by utilising the home appliance itself as the core, spanning the entire life cycle and integrating environmental, economic and social aspects. Samsung Electronics follows the concept of product life cycle and adopts corresponding strategies at each stage, which are mainly reflected in the following four aspects.

First, the utilisation and management of materials. The consideration of recycled plastic in the design of Samsung home appliances mainly lies in two aspects. The first one is the reuse of recyclable plastics. An example of this approach is the BESPOKE Grande AI washing machine. This washing machine uses at least 20% recycled plastic for the internal shelves and the outer shell of the detergent box, thereby reducing reliance on limited resources such as raw materials (Fig. 1).

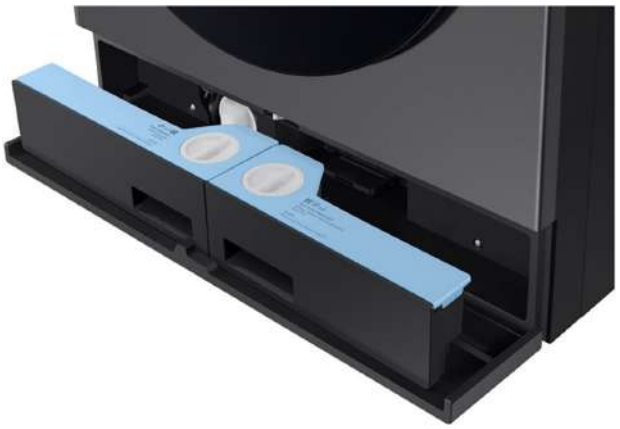

Figure 1. Automatic detergent dispensing compartment
Source: Samsung Electronics (n.d.c)

This approach reflects the transition of materials from a linear to a cyclic model. Transforming waste into usable resources is an important manifestation of the closed-loop utilisation of resource materials within circular design theory. The second is the solution to the problem of microplastics. Samsung Electronics not only optimises the design of its washing machine products but also collaborates with other technology companies to jointly develop a unique "micro-plastic low-reduction filter". This filter is not only suitable for Samsung washing machines but also compatible with washing machine products from other companies, demonstrating strong applicability (Fig. 2).

Figure 2. Less Microfiber Filter first presented at CES 2023
Source: Samsung Electronics (2023)

In addition, Samsung has introduced the Less Microfiber Cycle technology, which reduces the friction between clothes through washing cycles, thereby effectively slowing down the formation of microplastics. Cross-brand adaptability indicates that its design log-

ic has expanded from a single product to a systematic ecological collaboration level. Compared with the discussions on the end-of-life recycling issue of products in previous studies (Carlson *et al*., 2025), this practice systematically considers the dual paths of material recycling and control, and establishes a circular design strategy from the design front end to the post-production stage.

Second, enhance the energy efficiency of household appliances through their appearance design. Improving the energy efficiency of products is the key to the sustainable transformation of most home appliance enterprises. Samsung's contribution in this regard mainly involves achieving the goal of energy conservation by optimising the working mode of the design of home appliances themselves. In the design of the Yinxiangjia series of air conditioners (Fig. 3), the energy-saving and power-saving mode Wind-free can reduce electricity consumption in terms of performance, and the design of the product's appearance further promotes the focus on energy conservation.

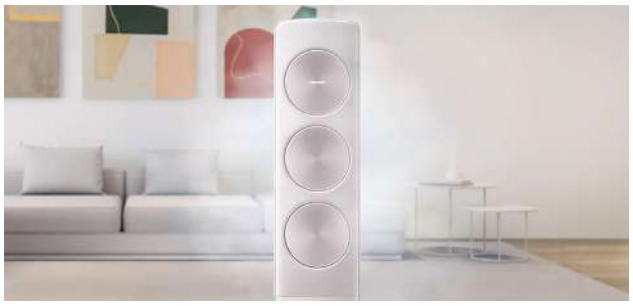

Figure 3. Yinxiangjia air conditioners
Source: Samsung Electronics (n.d.d)

The design of the air conditioner's air outlet is rotating, and the micro-hole design on the metal panel can promote the diffusion of cold air. Samsung unifies technical performance with product appearance in its design, not only contributing to energy conservation, but also influencing the visual characteristics of the product design. By optimising the appearance structure, the functional efficiency of household appliances can be enhanced, and differentiated and personalised appearance designs can be formed, demonstrating the harmony and unity of sustainable design in both technology and aesthetics.

Third, the durability of the materials and finishes of household appliances. In terms of the durability design of household appliances, the material and finish of the product's appearance are important entry points. The Samsung sterilising washing machine is designed with tempered glass doors (Fig. 4). The material is sturdy and durable, not easy to break or scratch. Even after repeated touch tests on opening and closing, the appearance still maintains a bright and beautiful texture. In addition, the compact design of the body ensures the optimisation of the usage space while reducing the product size. Moreover, it can achieve intelligent maintenance in the Samsung SmartThings (n.d.) application and is easy to maintain. The design strategies of material strength selection, compact design and intelligent management demonstrate the feasible practices of Samsung home appliances in delaying aesthetic aging, optimising product and spatial layout, and applying digital technology. This observation is consistent with the view of B. He & H. Mao (2023), who noted that the integration of digital technologies such as digital twins and low-carbon design approaches can contribute to improving the sustainability of products. These approaches reflect the evolution of home appliance from physical durability to systematic durability, and reinforce the core goal of sustainable design in extending the product life cycle from multiple dimensions.

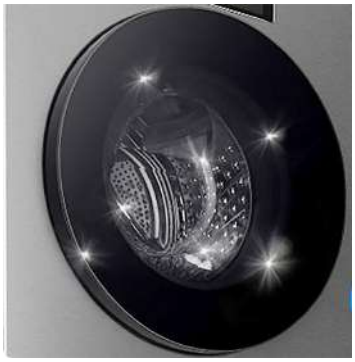

Figure 4. Tempered glass door of the washing machine
Source: Samsung Electronics (n.d.e)

Fourth, the recycling of product packaging. Relying on its main products, Samsung is committed to the research and development of additional products for home appliance packaging accessories, which is also an economical and sustainable behaviour. For instance, Samsung has also considered sustainable design in the packaging of its home appliances. The paper box packaging of Samsung vacuum cleaners can be reused to make various household items. Users can cut, fold and assemble stationery, bookshelves, piggy banks, shoe racks and other items according to the dotted lines on the packaging cardboard (Fig. 5).

In this process, not only is the reuse value of cardboard realised, but also users are guided to participate, strengthening their sustainable awareness through participatory experiences. With home appliances as the core, extending to the sustainability of related products such as packaging and remote controls, it means that Samsung's sustainable design for home appliances is different from the single consideration of home appliances themselves (Lima & Kubota, 2022). Instead, it uses the main products to drive the redesign of surrounding products and enhances product interaction and experience through fun design.

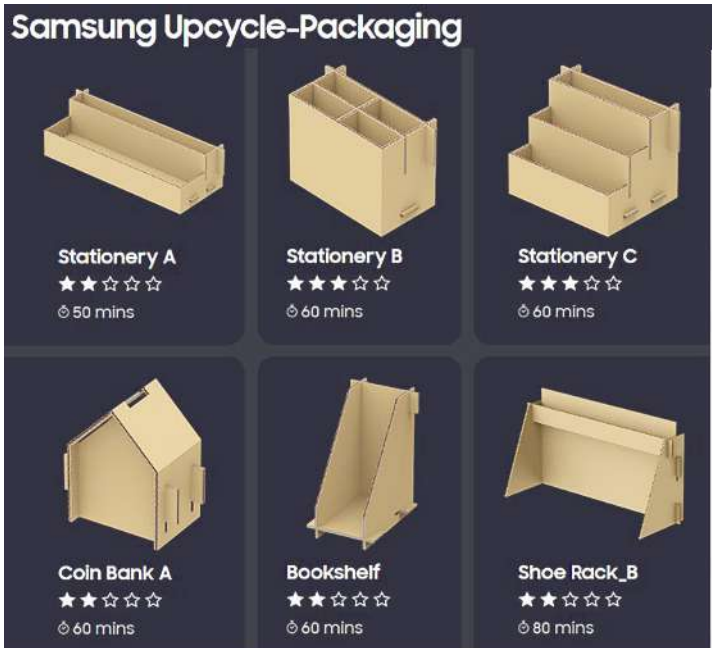

Figure 5. Circular packaging
Source: Samsung Electronics (n.d.f)

In addition, the full life cycle design and circular ecosystem are important strategies for the sustainable design of Samsung's home appliances. A comprehensive assessment of the entire product life cycle is conducted to achieve comprehensive and all-round management of resources. Attention is also paid to product recycling and utilisation, and waste electronic products are recycled and reused, fully realising environmental protection benefits. It can be seen that in the process of designing around the products themselves, Samsung Home Appliances have enhanced sustainability in multiple aspects such as material usage, performance optimisation, appearance design, and recyclable packaging. Unlike other home appliance enterprises, Samsung designs its home appliances in a compatible way rather than by completely redesigning them, achieving sustainable product improvement and reflecting an approach to product design optimisation. Furthermore, resource sharing and collaboration among industries also extend the impact of environmental protection innovation to the entire industry, which may contribute to the discussion of sustainable development strategies in enterprises.

User dimensions of sustainable design performance. In the user dimension, Samsung Electronics aims to enhance the user experience by integrating digital technologies and inclusive design approaches. In the era of digitalisation and intelligence, it creates a digital life centred on home appliances, integrating inclusive design and sustainability considerations. First, emphasise user retention through inclusive design, that is, all users can enjoy products and services equally. Samsung interacts with users through various channels to obtain user needs, considering user feedback and needs in product design, so that user needs can be equally met. And conduct in-depth interviews and online surveys for special groups, subdivides user groups, and evaluates product experience and design through user testing (Fig. 6).

Figure 6. In-depth interviews of the professional team
Source: Samsung Electronics (n.d.a)

Furthermore, in product design, it should be more user-friendly in aspects such as the operation interface, appearance form, and material selection. Through these design practices, Samsung not only meets the functional requirements but also integrates the concept of sustainable development into users' daily experiences through form, aesthetics and interaction methods. Second, Samsung considers accessibility for special user groups in the design of home appliances, which is reflected in four aspects: vision, hearing, movement and recognition (Fig. 7).

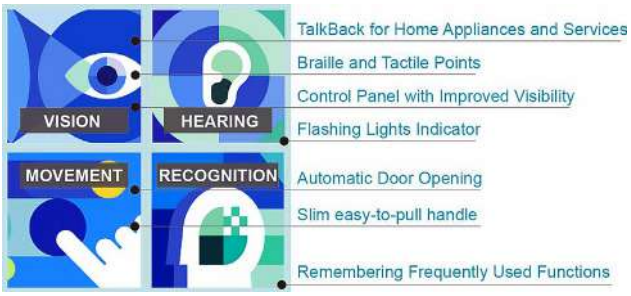

Figure 7. Humanised design in Samsung home appliances
Source: developed by authors

Samsung integrated visual aids, such as braille and tactile dots applied to product buttons, and an LCD panel with enlarged text, complemented by sound effects to distinguish between washing machines and dryers. For hearing, the refrigerator features flashing lights and audible alarms, while the display provides subtitles and videos to provide comprehensive information to hearing-impaired users. On the behavioural side, the refrigerator features a handy slim pull handle for comfort and ease of use. In terms of recognition, washing machine and clothes dryer products intelligently remember common procedures, eliminating setting steps and improving operation efficiency. In the icon design of household appliances, digital displays have replaced physical buttons, marking different usage states of the appliances through the use of simplified and standardised symbol forms. For example, a circle represents "push" and a triangle represents "pull" (Fig. 8).

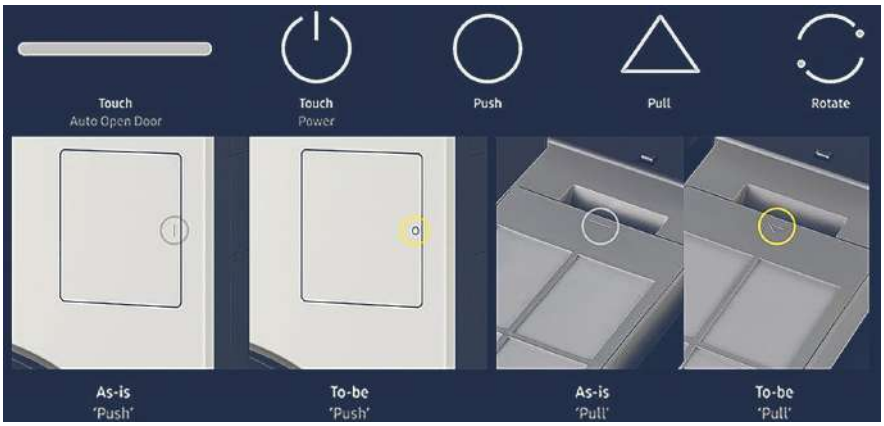

Figure 8. Indicative product icons
Source: Samsung Newsroom Global (2025)

Humanised design of household appliances enhances the satisfaction and usage experience of different user groups, thereby making household appliances a medium for communication between products and users, and achieving the sustainability of green consumption and brand trust. Third, personalised design of the appearance of home appliances based on user demands. In the BESPOKE refrigerator design of Samsung (Fig. 9), clean, minimalist lines of the shape give the overall form stability and a sense of order, designed to align visually with typical household environments.

In terms of form expression, this product uses low-saturation natural tones and soft neutral colours, extending the visual aesthetic life of the product. Materials like glass and metal are treated with matte finishes, delicate texture and soft reflection to unify the visual texture and touch, which may contribute to extending the perceived aesthetic longevity of the product. Designers, based on user preferences, view the product as a system that can continuously evolve in response to changes in user needs. Through unified and standardised structural design, different functional modules are freely combined to meet users' personalised demands.

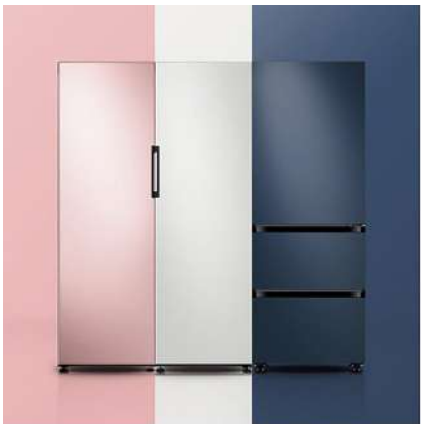

Figure 9. BESPOKE refrigerator
Source: Samsung Design (2026)

Samsung's focus on users goes beyond the meeting of basic product functions, incorporating user input and accessibility considerations in the design of home appliances. By emphasising inclusive design, considering the needs of different user groups, and focusing on user participation and barrier-free design. This

user-centred sustainable product design illustrates how integrating sustainable design into product development may influence consumer choices and corporate practices. By analysing and interpreting the content of a specific case study on the sustainable design of Samsung's home appliances, the key factors that influence and promote the sustainable design of Samsung home appliances can be explored. As a global environmental awareness that drives the sustainable innovation and transformation of enterprises both externally and internally, Samsung, as a representative home appliance company, can practice the diversity of sustainable development from multiple dimensions such as products, users, and society.

Sustainable design of household appliances is often understood as a matter of technological optimisation, performance improvement or life cycle management. However, the product design itself plays a significant role in the expression of sustainability. S. Ji & P.S. Lin (2022) pointed out that the concept of sustainability can be perceived by users through product forms, materials and aesthetic experiences. This perspective provides an important reference for the sustainable design of Samsung's home appliances. The design of Samsung's home appliances does not take environmental protection as an independent pursuit, but through systematic design, it jointly applies the product itself and user experience to the sustainable expression of home appliances.

Samsung Home Appliances takes products and users as the dual core to build a sustainable design ecosystem. This dual-core strategy makes product design not only focus on technology and environmental protection, but also emphasise user experience and social responsibility, forming an organic whole. Unlike the technology-driven path, emphasised by B.K. Sovacool *et al*. (2022), Samsung's home appliance design, in terms of appearance form, colour and material treatment, weakens the technical attributes of the products visually and enhances the user affinity. This aligns with the view, proposed by E.M. da Silva *et al*. (2025), which suggests that sustainable behaviour can be promoted through design experience. The synergistically driven ecosystem integrates advanced technologies, collaborative innovation, and user feedback to facilitate product iteration and user needs and technological innovation.

The management of the product life cycle has become an indispensable strategy in the development of most enterprises. It is not only a direct initiative to comply with environmental protection, but also an in-depth consideration of the entire product process, and a process of seeking a balance between sustainability and commercial reality (Sun *et al*., 2023). Research shows that Samsung Home Appliances has reshaped the product life cycle with the goal of sustainable development. In the design stage, household appliances have reduced the decorative and trendy elements in terms of colour and shape, maintaining visual aesthetic stability and meeting users' diverse aesthetic needs. This behaviour supplements the research that mainly discusses the life cycle from the perspective of engineering management, indicating that design form and aesthetic stability are both important factors influencing product sustainability.

User-oriented inclusive design is the most prominent feature of Samsung home appliances. J.H. Lee *et al*. (2025) pointed out that inclusive design is not only reflected in the usability of the functional, but should be integrated into the overall design experience. Samsung Home Appliances, through in-depth research on the needs of user groups, ensures that the design of its products takes into account the expectations of both mainstream users and special groups. This makes Samsung's appliances are not just a collection of functions, but a full understanding and respect for the diversity of users. In the era of new products, users play an important role in providing feedback for product design and development. Only by grasping the key information on the demand side of the product can innovation and upgrading on the supply side be achieved with the support of technology. The whole process is dynamic and circular, and the user-oriented inclusive design not only wins social recognition for the enterprise, but also expands the market audience of the product which may influence the public perception of the brand.

Overall, in its research on sustainable design for home appliances, Samsung has comprehensively considered the products and users as well as the systems they form. It has enriched the context of sustainable expression for home appliances from dimensions such as material usage, modular design, energy efficiency improvement, and product packaging. At the same time, it has supplemented a user-centred perspective on sustainability through inclusive design, barrier-free design, and humanised design. Samsung's experience may serve as a reference case for other enterprises.

CONCLUSIONS

Thr ough the case analysis and strategy discussion of Samsung home appliances sustainable design, it can be seen that the expression of sustainability in home appliances is diverse, especially by combining user needs with the products themselves and presenting them visually from multiple aspects such as materials, colours, and shapes. The analysis showed that the product-user dual-core design ecosystem constructed by Samsung Home Appliances was conducive to comprehensively enhancing user perception and usage experience. It was found that the impact of design on the product life cycle could be optimised through aesthetic durability constituted by external manifestations such as materials and colours. The research results on inclusive design indicated that the sustainable design of household appliances was not only achieved through the optimisation of interfaces or operation methods,

but was also realised by simplifying forms and optimising the combined effects of multiple sensory channels. The analysis further demonstrated that Samsung Home Appliances may inform approaches to brand positioning and sustainable design implementation in the home appliance sector. The continuous progress of technology will provide more possibilities for product design, and user interest in social responsibility and sustainability may influence enterprise strategies. Home appliances play a central role in daily household operations, and the attention and satisfaction of users' needs are not blind, but based on sustainable values guidance, and effectively promote fairness through product design. In the future, the home appliance industry will pay more attention to innovation and practice of sustainable design. Further in-depth research will be conducted around product form innovation, the application of ecological materials, and the guidance of users' sustainable behaviours, promoting the development of home appliance design towards a more ecological, humanistic and fair direction.

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CONFLICT OF INTEREST

None.

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Інноваційний дизайн за принципами сталого розвитку: тематичне дослідження на основі електроніки Samsung

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Анотація. В умовах сталого розвитку важливим напрямом є сталий дизайн і трансформація побутової техніки. Метою цього дослідження було вивчення дій і стратегій компаній-виробників побутової техніки у сфері сталого проєктування продукції. Як основний об'єкт дослідження було обрано продукцію компанії Samsung Electronics. У роботі було застосовано метод кейс-стаді та стратегічного аналізу для опрацювання інформації й узагальнення виявлених тематичних аспектів. У межах сталого проєктування продукції компанією було сформовано екосистему перероблення, центром якої виступає побутова техніка, а допоміжні продукти розглядаються як ключова точка входу. Під впливом зовнішнього політичного середовища, корпоративної соціальної відповідальності та технологічної коінновації здійснюється пошук шляхів сталої трансформації з урахуванням корпоративної специфіки. Було виокремлено три основні елементи стратегії сталого дизайну: формування дизайн-екології, що ґрунтується на взаємодії продуктів і користувачів; переосмислення та оптимізацію управління життєвим циклом продукту; а також користувацько-орієнтований інклюзивний дизайн. Показано, що ці елементи відкривають нові перспективи для подальших досліджень і практики. Глобальний перехід до більш екологічного виробництва побутової техніки підкреслив важливість співпраці між підприємствами. Практичний досвід Samsung Electronics може слугувати для дизайнерів і дизайн-компаній наочним і практично застосовним орієнтиром, а також допомогти підприємствам розробляти різноманітні стратегії сталого розвитку з урахуванням власних умов. Практичне значення цього дослідження полягає в тому, що його результати можуть слугувати в якості рекомендацій для дизайнерів та компаній у сфері побутової техніки, демонструючи, як стратегії сталого дизайну можна ефективно інтегрувати у розробку продуктів та користувацький досвід

Ключові слова: сталий дизайн; побутова техніка; дизайн продукту; зручність використання; кейс-аналіз