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Integrating Circular Economy Principles into New Product Development: Challenges and Opportunities in the Household Appliance Sector.

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The household appliance sector significantly impacts on the environment, consuming large quantities of finite raw materials and energy while contributing to the growing issue of electrical and electronic waste (e-waste) (APPLiA Italia, 2018; Eurostat, 2023). According to the European Commission (2021), e-waste recycling rates remain below 40%, with most discarded products incinerated or landfilled, rising resource depletion, carbon emissions, and health risks (European Commission, 2023a; European Parliament, 2024).

As corporate social responsibility gains prominence and consumer awareness of ecological challenges increases, the urgency for sustainable innovation intensifies (Bressanelli et al., 2020). Regulatory frameworks, such as the European Commission's Circular Economy Action Plan (CEAP) and the upcoming Ecodesign for Sustainable Products Regulation (ESPR), which entered into force in July 2024, are accelerating this shift. These policies promote a transition from the traditional linear production model to a circular approach, where products and materials are designed to be maintained, reused, refurbished, remanufactured, or recycled, effectively eliminating the concept of "end-of-life" (European Commission, 2023b; The Ellen MacArthur Foundation, 2022).

While numerous studies highlight the importance of aligning the New Product Development (NPD) process with Circular Economy (CE) principles (Nyström et al., 2021), research on effectively combining NPD processes with circular business models remains limited (Aguiar & Jugend, 2022). This study contributes to the literature by conducting a systematic review of existing NPD processes and circular practices, offering a comprehensive examination of how these can be integrated to foster business innovation. Adhering to the PRISMA protocol, the review ensures a rigorous selection of relevant literature from Scopus (Baas et al., 2020).

Findings underscore the central role of designers in aligning sustainability goals with market demands. They are responsible for developing durable, resource-efficient appliances that minimise environmental impact while maintaining global competitiveness (Baldassarre et al., 2019; Sumter et al., 2018). The study also emphasises the significance of the fuzzy front-end phase in NPD, where early-stage decisions on circular strategies can have long-lasting effects. Key enablers include interdisciplinary collaboration, customer engagement, and strong leadership support. By incorporating circular design principles, such as product-service systems, durability, and repairability, companies can extend product lifecycles and reduce resource consumption (Aguiar & Jugend, 2022; Dokter et al., 2021; Toth-Peter et al., 2023).

However, businesses face considerable challenges in adopting circular practices in the NPD, including technological, financial, organisational, and knowledge-related barriers (Aguiar et al., 2022; Sumter et al., 2021). This research identifies these obstacles and suggests pathways to help overcome them, enabling a successful transition to circular product development.

In conclusion, integrating circular economy principles into NPD offers substantial opportunities for sustainability and innovation in the electrical and electronics sector. Future research should focus on refining these strategies and exploring their practical application in real-world business contexts.