

An aerial photograph of a dense green forest with a prominent, winding river that meanders through the landscape. The river is a vibrant blue, contrasting with the deep green of the trees. The overall scene is a natural, healthy ecosystem.

Rethink:

Why sustainable product design is the need of the hour

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Introduction

Modern product design processes put great emphasis on the concept of “user-centricity.” However, while focusing exclusively on the needs of one group of stakeholders (the user or consumer) may have made sense in a purely commercially driven business framework, such an approach could have unintended negative consequences further down the line – both for other stakeholders and for the environment. An estimated 80 percent of environmental impacts associated with products result from decisions made at design stage.¹ For truly systemic change to occur, sustainability must be central to product design decisions.

L’Oréal Group is working to direct the focus of its product development teams towards sustainability, supported by data and technology. With the development of its Sustainable Product Optimization Tool (SPOT), the organization has been able to quantify

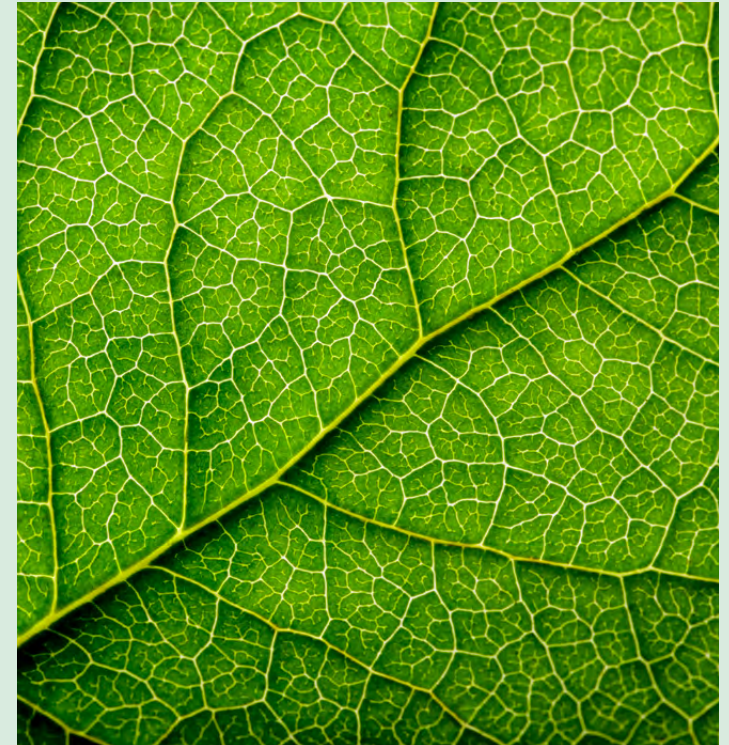
the environmental and social performance of all L’Oréal products across their lifecycles and tracks progress in four areas targeted for improvement: packaging, carbon footprint of the formula, sourcing of ingredients, and social benefits of the product. All L’Oréal products created since 2019 have been evaluated using the SPOT tool, and 85 percent of new or updated products in 2019 had an improved environmental or social profile.²

For instance, L’Oréal launched a solid shampoo with an improved formula that lasts as long as two 250ml liquid-shampoo bottles and reduces water consumption through its fast-rinse technology. It also uses recycled cardboard packaging instead of plastic. Improvements such as these have resulted in an 80 percent reduction in primary packaging and a 30 percent reduction in greenhouse gas (GHG) emissions across the product’s lifecycle compared to those of a

Introduction

standard shampoo bottle.³ In addition to these environmental benefits, L'Oréal has been able to generate positive social impact through sustainable product design. For instance, the use of sustainably sourced shea butter for L'Oréal's Aqualia Thermal skincare product provides a market for more than 35,000 women producers in Burkina Faso.⁴

Through this research, we wanted to understand how far organizations have progressed with embedding sustainability in their product design decisions, and how data and technology can enable this process. We surveyed 900 senior product design and engineering executives from large organizations across industries including consumer products, automotive, industrial manufacturing, aerospace and defense, high-tech, and medical devices. We also interviewed 15 senior industry executives and academics (for more details, please see the Research Methodology).



Introduction



+ This report aims to answer the following questions:

01

Why do organizations need to focus on sustainable product design?

02

To what extent are organizations currently prioritizing sustainable product design?

03

Which factors are holding back progress on sustainable product design?

04

How can organizations adapt themselves to support sustainable product design?

The scale of implementation of sustainable design initiatives may differ significantly across industries due to the varying size and complexity of products. This research is intended to provide broad guidance regarding sustainable product design approaches, strategies, and recommendations.

Definitions

+ Defining sustainable design

Sustainable design* can be defined as “maximizing environmental, social, and economic benefits over a system’s lifecycle, while minimizing associated social and environmental costs.”⁵

This definition reflects the “triple-bottom-line” accounting framework, where the performance of a system is measured not only by the profit it generates, but also by positive impact on people and the planet. Effective sustainable design is forward-thinking; it addresses future business risks, fosters innovative solutions, and keeps pace with evolving consumer needs. It means staying vigilant for opportunities to develop a point of difference in the market and lay the groundwork for long-term success.

**For the purpose of this research, the term product design refers to any of the decisions regarding research and development (R&D), design, and engineering for one or more products within the organization’s product portfolio. Similarly, designer refers to senior design executives responsible for decisions regarding R&D, design, and engineering elements for one or more products within the organization’s portfolio.*

In this report, we focus on organizations that principally manufacture physical products. Some of these products may incorporate software elements or have accompanying apps. Therefore, sustainable product design strategies for digital products are also covered.

Fig.1

Sustainable design strives to have a positive impact on people, planet, and profits



Source: Synapse, part of Capgemini Invent.

Executive summary

Sustainable product design is a business imperative

As the need for radical climate action intensifies, organizations need to pay close attention to product design given that an estimated 80 percent of the environmental impacts of a product are linked with decisions made at design stage.⁶ Crucially, sustainable product design is a key lever that can help organizations achieve the transition to net zero. Product emissions⁷ can account for a major share of organizations' overall emissions and sustainable design strategies will be key to mitigating them. More than two-thirds (67 percent) of organizations in our research have seen a reduction in carbon emissions due to the implementation of sustainable product design strategies.

Further, against a backdrop of rising raw material scarcity, driven by environmental and geopolitical factors, organizations also need to reduce their reliance on virgin materials and build supply chain resilience. Sustainable design strategies are key to meeting these goals by enabling a shift to a circular economy that decouples growth from the consumption of finite resources. Strategies such as

dematerialization, and designing for product durability, repairability, modularity, recyclability, and recoverability ensure that material usage is reduced, and products and materials can be kept in use for longer. Moreover, half of global greenhouse gas (GHG) emissions and 90 percent of biodiversity loss have been attributed to the extraction and processing of primary raw materials.⁸ By reducing reliance on primary raw materials, organizations have the opportunity to accelerate progress towards sustainability goals, while also building resilience against future supply shocks. Recycling aluminum, for instance, saves 97 percent of GHG emissions produced in the primary production process.⁹

67%

Share of organizations that have seen a reduction in emissions due to sustainable product design initiatives

Executive summary

In addition to these imperatives, organizations face increasing regulatory pressure to design more sustainable products. For instance, the European Commission's proposed Ecodesign for Sustainable Products Regulation aims to make sustainable products the norm in the EU market.¹⁰ Organizations that focus on sustainable product design not only stand to gain from improved compliance, reduced emissions, and reduced resource scarcity concerns, but can also reap benefits such as increased revenue growth and improved relationships with customers and employees. Seventy percent of organizations in our research report an increase in customer satisfaction levels due to sustainable product design.

Sustainability is not at the core of product design processes

Despite the urgent need for action, only 22 percent of respondents in our survey say that sustainability is a key component of their product design processes. While awareness is critical to action, designers have limited awareness of the environmental and social impacts

of products, and only about one-quarter of organizations conduct regular environmental and social impact assessments as part of the product design process. Of these, only 8 percent regularly conduct both. Further, sustainable product design requires a mindset shift towards systems thinking and circular design, as designers must consider product impacts holistically. However, only 12 percent of organizations have incorporated a systems thinking approach to product design so far. In addition, only a handful are taking concrete action to improve product sustainability.

Cost concerns hinder sustainable product design

An increase in cost is often seen as a roadblock in sustainable product design. However, our research shows that sustainable design does not always lead to increased cost – with 23 percent of respondents saying costs have actually decreased due to adoption of sustainable design strategies and 37 percent saying they have remained the same. Of those organizations that reported an increase in costs, 51 percent also say this has already been outweighed by increased benefits.

Executive summary

While cost is often the primary hurdle, there are other internal and external challenges organizations must overcome. Fifty-five percent of organizations cite as a key challenge a lack of availability of sustainable materials and 54 percent a lack of data with which to accurately assess environmental and social impacts of products. Organizations also lack fundamental sustainable design skillsets, such as systems thinking and circular design thinking. Further, while technologies such as Life Cycle Assessment (LCA) tools, artificial intelligence/machine learning (AI/ML), additive manufacturing, bio-innovation, and digital twins can significantly aid sustainable product design, most organizations do not have adequate capabilities in these areas.

How can organizations support sustainable product design?

We have identified the following actions that organizations need to take in order to design and deliver sustainable products:

- **Make sustainability a core design priority and emphasize the need for systems change**

Organizations must define clear sustainability goals and objectives for product design teams, establish clear accountability for sustainable product design, and develop guidelines and tools to help product design teams evaluate trade-offs and alternatives. Adopting a data-driven approach is critical. Organizations need to measure environmental and social impacts across the product lifecycle to identify high-impact areas. Further, organizations must invest in upskilling product design teams in order to enable a mindset shift towards systems thinking and circular design. However, less than a third (28 percent) of organizations are upskilling design teams with sustainable design skillsets.

- **Establish processes and partnerships across the product value chain**

Collaboration with stakeholders across the value chain and between teams to jointly determine design decisions, based

Executive summary

on impact and feasibility, is critical to achieving sustainability. Organizations must set up cross-functional teams to accelerate sustainable product design. Also vital is investment in partnerships to build new competencies, and in services to enable an overall shift in business models towards circularity.

- **Manage costs through re-evaluating concepts and taking a long-term view**

A mindset shift is required to urgently advance the sustainability agenda. Organizations should consider adopting a True Cost Accounting (TCA) approach that assesses product costs holistically – including environmental and social costs. Further, when evaluating investments in sustainable product design, organizations must take a long-term view that considers long-term benefits, such as cost savings, reduced exposure to risks, increased revenues, and improved customer satisfaction. Organizations should also educate consumers on the environmental and social costs of products and guide them towards more sustainable choices.

- **Harness technology to support sustainable product design efforts**

Technology can help organizations take big strides towards these actions. Advances in technology are opening up numerous opportunities for sustainable product design. This is driven by two major technological trends: first, the **merging of physical and digital worlds** enabled by technologies such as IoT, AI/ML, and digital twins, which allows for increased material traceability, and enhanced design and simulation capabilities; and second, **advances in the field of bio-innovation** that are enabling the discovery of biologically sourced or inspired alternatives for scarce or unsustainable materials and carbon-intensive processes. Organizations must therefore step up their use of technology and investments in research and innovation and ensure that product design teams work closely with data and digital experts. When investing in technology, organizations must also account for the emissions resulting from the use of that technology.

An aerial photograph of a vast mangrove forest. A prominent, winding river or canal cuts through the dense green vegetation, creating a complex, meandering path. The water reflects the sunlight, creating a shimmering effect. The overall scene is a lush, natural landscape.

01

SUSTAINABLE PRODUCT DESIGN IS A BUSINESS IMPERATIVE

Fig.2

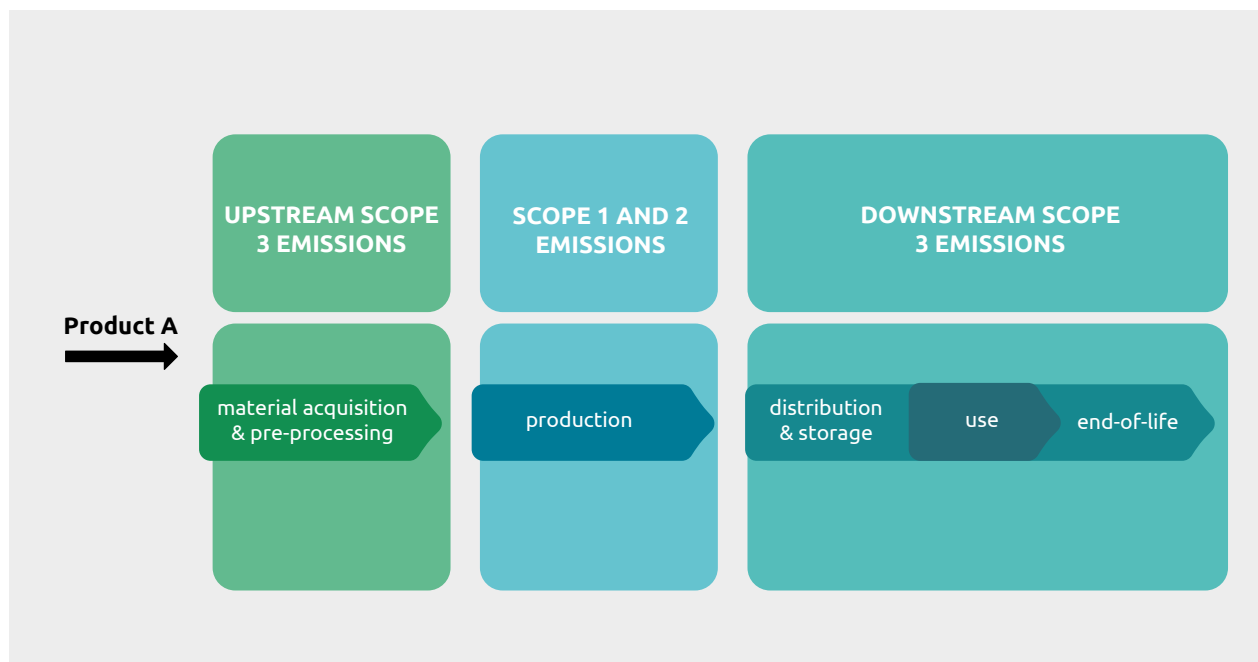
Example illustrating how scopes of emissions at corporate level correspond to lifecycle stages at product level

In this section, we look at the key business imperatives that are driving the need for urgent action on sustainable product design.

Sustainable product design is a key lever in the transition to net zero

Global GHG emissions need to be halved by 2030 and reach net zero by 2050 to avoid the worst impacts of climate change.¹¹ As organizations set net zero targets and plan their transition to net zero, tracking and accounting for product emissions will be critical. Product emissions refer to emissions generated during a product's lifecycle – i.e., across the stages of material acquisition and pre-processing, production, distribution and storage, use, and end-of-life treatment. Product emissions impact all three emission scopes that comprise an organization's overall emissions footprint (see Figure 2).

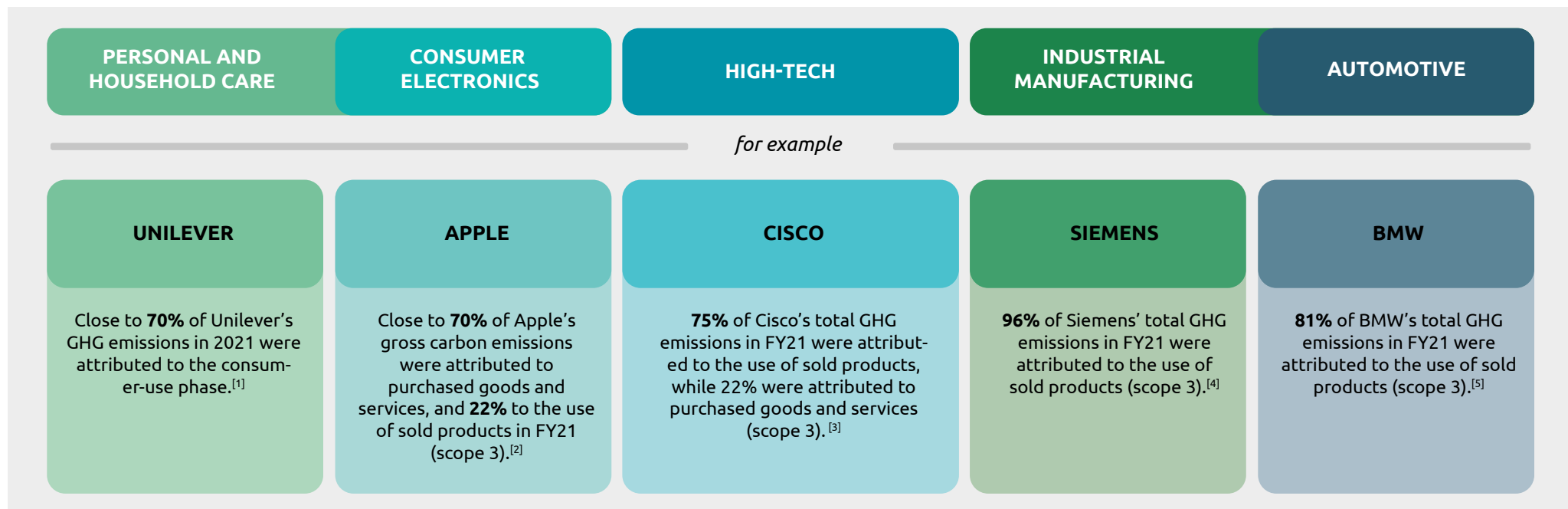
Product emissions can account for a major share of an organization's total emissions. Figure 3 highlights examples of organizations from varied industry sectors to illustrate this.



"The sum of the lifecycle emissions of each of a company's products, combined with additional scope 3 categories (e.g., employee commuting, business travel, and investments), should approximate the company's total corporate GHG emissions (i.e., scope 1 + scope 2 + scope 3)."¹²
Source: GHG Protocol Product Life Cycle Accounting and Reporting Standard.

Fig.3

Product lifecycle emissions can account for a significant share of organizations' overall emissions



*Emissions from purchased goods and services include emissions resulting from material acquisition and pre-processing, and contract manufacturing, where applicable

^[1] Unilever, *Unilever Annual Report and Accounts 2021*.

^[2] Apple, *Environmental Progress Report: Covering fiscal year 2021*.

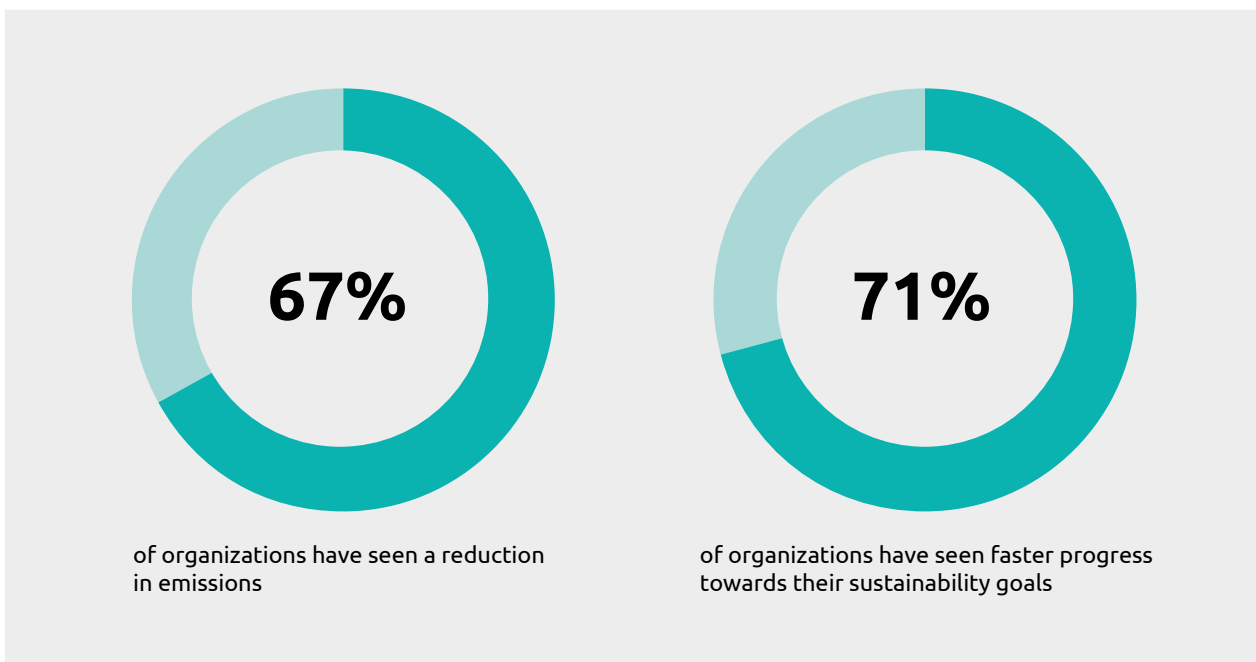
^[3] Cisco, *2021 Cisco Purpose Report*.

^[4] Siemens, *Sustainability report 2021*.

^[5] BMW, *BMW Group Report 2021*.

Fig.4

Impact of sustainable product design initiatives



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=889 organizations that have implemented at least one sustainable design strategy.

Design decisions are a key lever in reducing emissions across the product lifecycle. More than two-thirds (67%) of organizations in our research say that they have seen a reduction in emissions due to their sustainable product design initiatives (see Figure 4).

Even when product emissions largely stem from the customer use phase, as seen in Figure 3, design decisions can influence and help reduce emissions, as in the examples below:

- Cisco is making its products more energy efficient in order to reduce use-phase emissions; Cisco's 8201 range of routers consumes 26x less power than its predecessor, due to innovations in silicon design.¹³
- Unilever is reformulating products to lower use-phase emissions – for instance, it launched a range of liquid laundry detergents with plant-based stain removers, which are suitable for low-temperature washing and have a lower GHG impact than laundry powders.¹⁴

Given the contribution of product emissions to organizations' overall GHG footprint, and the impact of product design decisions on mitigating these emissions, organizations should pay close attention to product design decisions as they chart their journey towards net zero.

Sustainable product design decisions also lead to other environmental and social benefits

While most organizations are currently focusing on reducing carbon emissions, it is important to also minimize negative impact on other environmental resources and stakeholders. Sustainable product design can help organizations attain their overall environmental and social sustainability goals. According to our research,

71 percent of organizations have seen faster progress towards their sustainability goals as a result of sustainable product design initiatives (see Figure 4).

Electronics manufacturer Fairphone is an interesting case study of an organization that focuses on product design to improve its environmental and societal impacts. Fairphone aims to motivate the massive global electronics industry to take responsibility for its impact on the world.

The company incorporates sustainability into its design process by focusing on four key areas: longevity, circularity, sourcing “fair” materials, and ensuring good

working conditions. The company designs its products to be modular to facilitate easy repair. Its focus on circular concepts encourages efficient use of critical resources. In 2020, the company refurbished and resold 40 percent of phones collected; the rest were recycled for parts and materials. Further, use of conflict-free materials ensures better conditions for communities where conflict metals are mined, in countries such as the Democratic Republic of Congo (DRC). The company is working to integrate fairer cobalt and lithium into its batteries and is the first – and to date, only – Fairtrade Gold-certified smartphone company.¹⁵

“What we do, and where most companies can improve, is taking a holistic approach: looking at the entire supply chain, from material extraction to how the customer uses the phone and how it is discarded. We keep questioning how we can make sure everything is as good as possible for people and the planet.”

-Ronald van Harten,
Head of Marketing for [Fairphone](#)



Designing for a circular economy is key to managing resource scarcity

Organizations across industries are vulnerable to raw material supply chain disruptions caused by resource scarcity, which is often aggravated by social and geopolitical issues. Extraction and processing of metals such as copper, nickel, cobalt, lithium, and rare earth metals is concentrated in very few resource-rich countries. Approximately 70 percent of today's mined cobalt, for example, originates from DRC and most of its refining operations are situated in China, accounting for 60 percent of the refined cobalt supply in 2018.¹⁶ An additional, and monumental, problem with metals mining and extraction in countries such as DRC is the lack of human rights protection – child labor and fatalities are common. Nonetheless, demand for these materials is expected to soar. While cobalt content in EV batteries has been cut significantly in recent years, increase in sales is expected to push cobalt demand from nearly 39,000 tons in 2020 to 120,000 tons by 2025.¹⁷

Resource scarcity and supply-chain constraints augmented by global disruptions are not restricted to metals. Christine Levêque, Global Vice President, Collection & Recycling, at Tetra Pak, says:

“COVID first, and now the invasion of Ukraine, are challenging the access to raw material for all industries including the food and beverage industry. More and more companies wish to relocate their supply chain; however, it requires a systemic change and profound investments. Forests and paper mills cannot be relocated overnight.”¹⁸

Designing for circularity can help organizations assuage their resource concerns. They should prioritize reducing resource use by extending product lifetime (by designing for durability, repairability, and product evolution) or by decreasing the amount of material used (dematerialization). Reuse and remanufacturing of products or components is the next most efficient option. While recycling also keeps scarce materials in the loop, it may be accompanied by degradation in material quality. Additionally, recoverability of materials can be improved by designing products to be modular and easy to disassemble, and product traceability can be enhanced by incorporating technologies such as RFID, blockchain, and IoT.

Source: Capgemini social media analysis, June 2020–April 2022.

Realizing the magnitude of the problem, BMW Group plans to incorporate circular thinking into its Neue Klasse models. Oliver Zipse, Chairman of the Board of Management of BMW AG, comments:

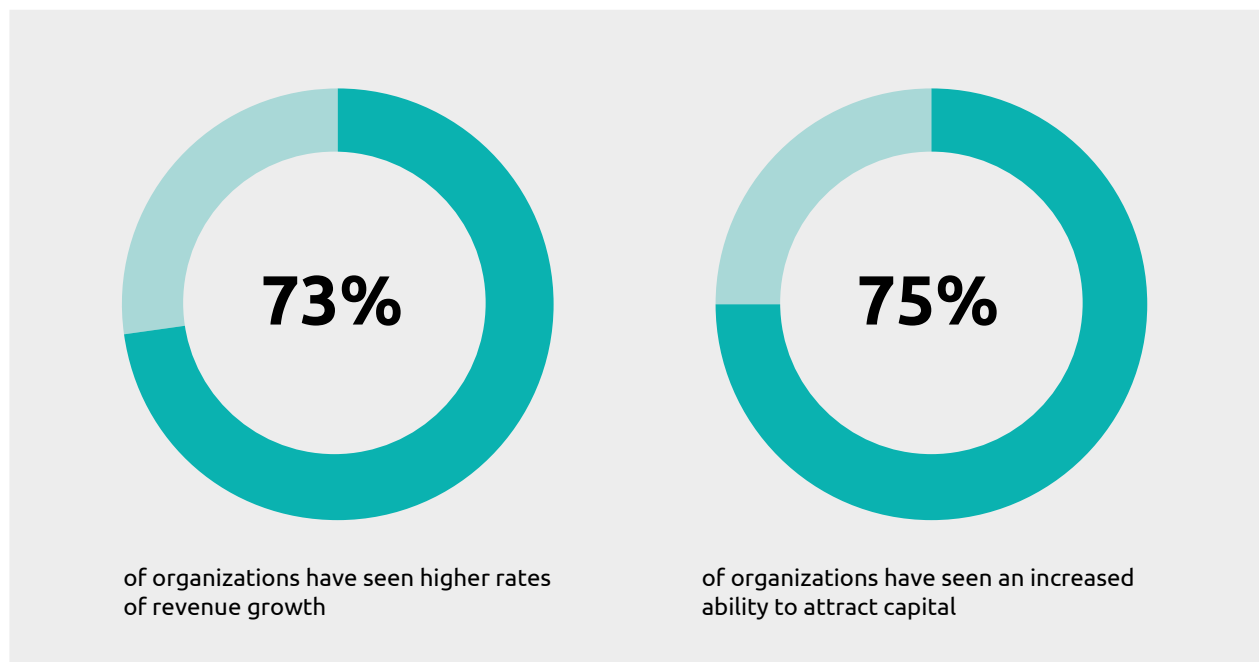
"We must design our vehicles for sustainability from the very first day of development: reducing the amount of material used to manufacture them and, above all, planning for reuse and recycling from the very beginning. In the face of rising raw material prices, this is not just an environmental, but also a business imperative."¹⁹

The group will significantly reduce resource consumption per vehicle, and substantially increase the percentage of secondary material used, such as recycled steel, plastics, and aluminum. The electric motor in the BMW iX, for example, no longer requires the use of rare earth metals. The group also believes that efficient dismantling



Fig.5

Sustainable product design initiatives can result in financial benefits



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=889 organizations that have implemented at least one sustainable design strategy.

capability is a key aspect for secondary materials to be able to compete in the marketplace. This capability can be achieved by not securing connections with adhesive but designing them so they can be detached at the end of the vehicle life, and ensuring materials are not mixed.²⁰

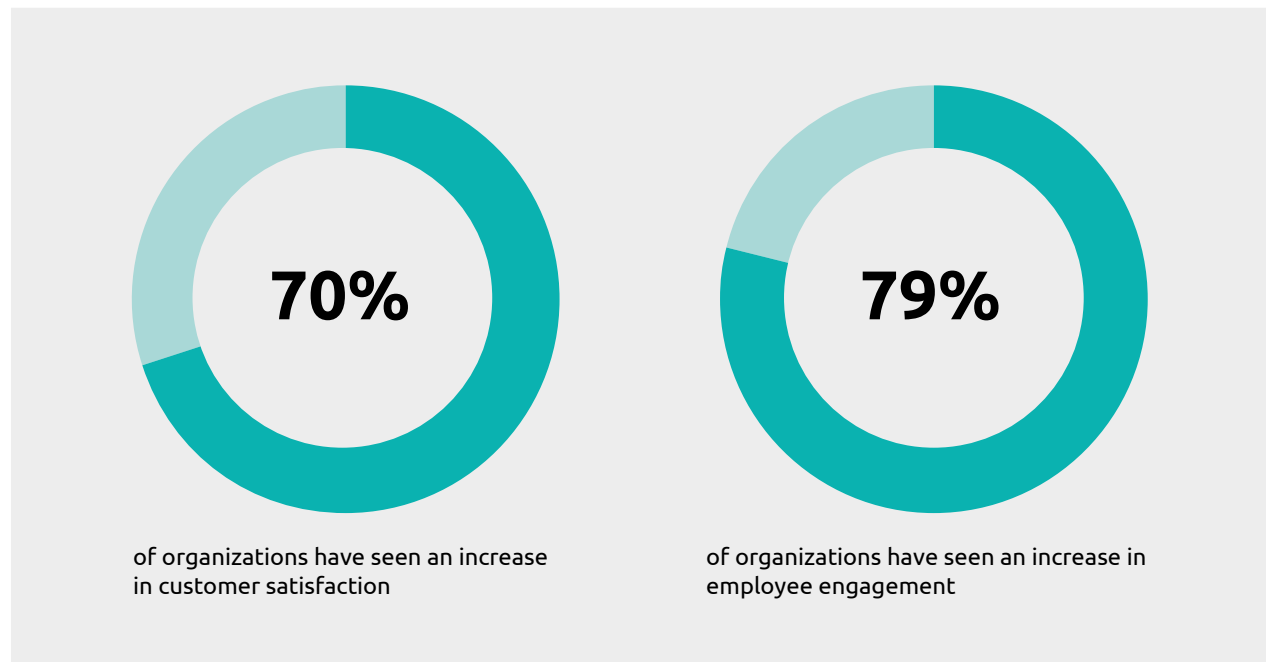
Financial benefits and improved stakeholder relationships are other positive side-effects

In addition to the environmental and social benefits, sustainable product design initiatives are also positively impacting financial performance (see Figure 5) and increasing customer satisfaction and employee engagement (see Figure 6).

HP's sustainable product design initiatives, for example, have already translated into financial gains for the company. HP views sustainable product design as a key driver of the circular and net zero carbon economy. The company has set ambitious targets for itself, including increasing product circularity (through improved product longevity, repair, and reusability, among other areas); using sustainable materials; reducing energy and water consumption during product use; and responsibly sourcing paper and packaging materials to protect forest cover. During 2021, HP used 134,000 tons of recycled plastic to manufacture cartridges; it is estimated that, by upcycling these materials, HP has kept 962 million Original HP cartridges, an estimated 143 million apparel hangers, and 5.5 billion post-consumer plastic bottles out of landfill.²¹ HP's focus on sustainable product design is also positively impacting its bottom line: in 2021 the organization reported \$3.5 billion in new sales due to the sustainable aspects of the products – tripling from about \$1 billion in the previous year.²²

Fig.6

Sustainable products strengthen consumer and employee relationships with the organization

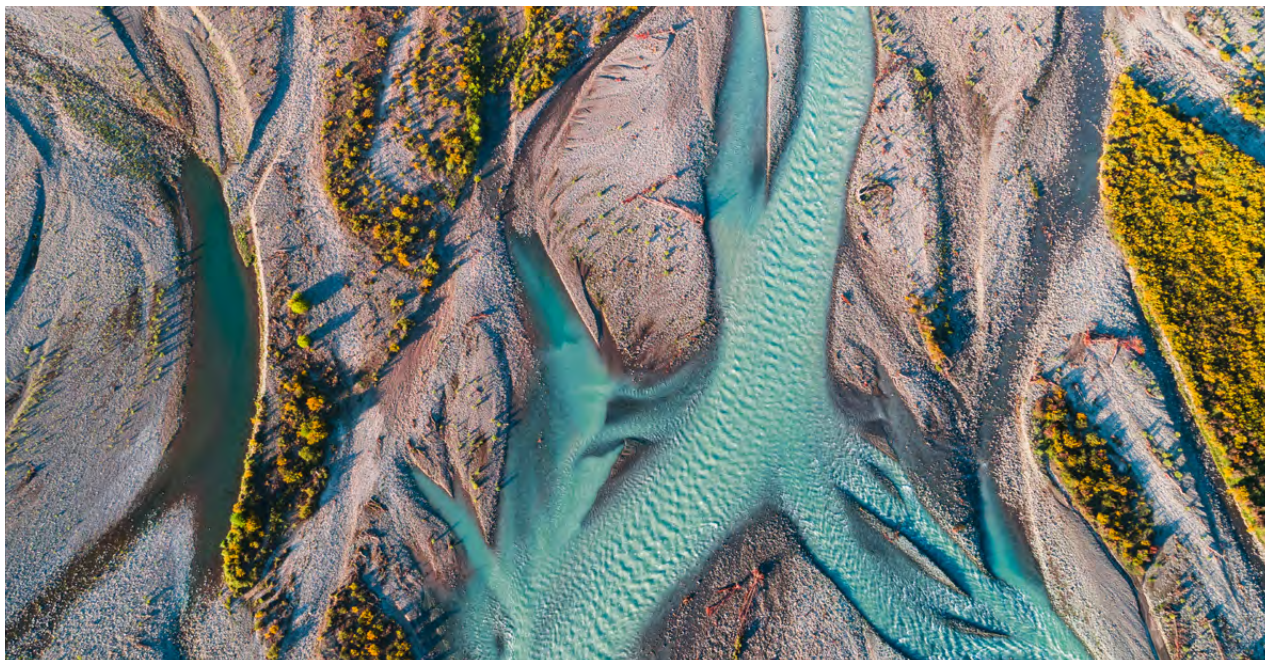


Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=889 organizations that have implemented at least one sustainable design strategy.

Alex Cho, President of Personal Systems at HP, says:

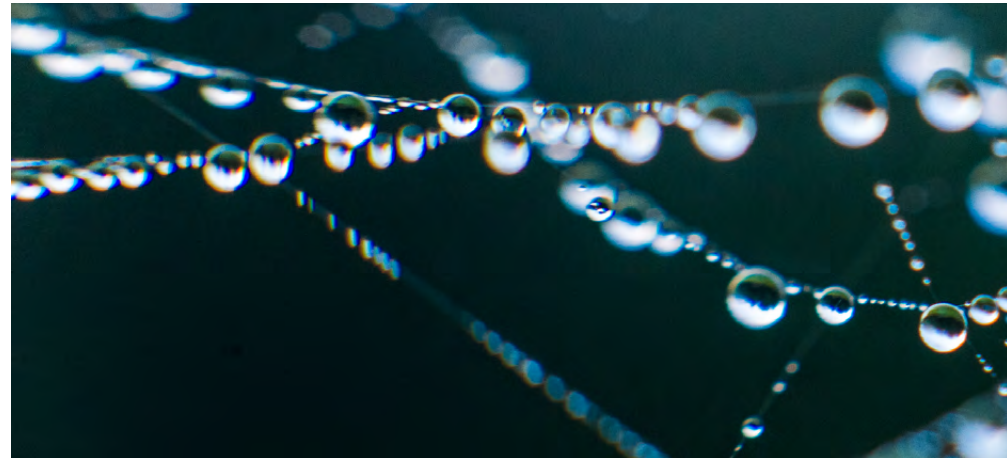
“At the beginning, when we first started the sustainable impact investments, it definitely felt like an either-or ... but now we have so much of our business where sustainability is the innovation that drives sales, that shows you demand.”²³

Seven in 10 organizations in our survey report an increase in customer satisfaction levels due to the adoption of sustainable product design initiatives, underlining consumers’ interest in the ethical status of products and brands. In our 2021 consumer survey, 60 percent of respondents agreed that post-pandemic, sustainability will be even more important to them as consumers.²⁴ Further, our previous research found that consumers are keen to adopt circular practices: 70 percent of consumers in our survey said they were interested in maintaining and repairing products to increase useful product life, and 54 percent said they would like to repurpose and reuse products.²⁵ Organizations that focus on sustainable product design stand to gain from stronger customer relationships and increased competitive differentiation.



Moreover, nearly eight in 10 (79 percent) organizations report an increase in employee engagement due to sustainable product design initiatives. Nicolas Veauville, General Manager Espresso, BU Coffee, Philips Domestic Appliances, highlights that increased employee engagement is one of the most significant benefits of sustainable product design:

“When employees feel that they are working in an organization that is doing the right thing for the planet, this keeps engagement levels high. You can make quite a difference in employee engagement, and we are already seeing this as a company.”



Martin Charter, Professor of Innovation and Sustainability and Director of The Centre for Sustainable Design at the University for the Creative Arts in the UK, also emphasizes the need to switch to more sustainable products:

“The new green consumer wave post COVID-19 is different from the past, since it is not just about climate change, but also biodiversity, nature, and the social dimension of sustainability. Organizations will need to focus on these dimensions to engage younger, more proactive generations as they move into consumer and employee roles.”



“The new green consumer wave post COVID-19 is different from the past, since it is not just about climate change, but also biodiversity, nature, and the social dimension of sustainability. Organizations will need to focus on these dimensions to engage younger, more proactive generations as they move into consumer and employee roles.”



Martin Charter

Professor of Innovation and Sustainability and Director of The Centre for Sustainable Design at the University for the Creative Arts in the UK



Organizations are feeling the pressure from regulators

Regulatory pressure across geographies is slowly pushing organizations to make more sustainable products. Among organizations that focus on sustainable product design (or plan to in the future), 61 percent cite regulatory pressures as a top driver. Some examples of regulations and directives that impact product design are:

- **Use of recycled content in products or packaging.** The European Commission has proposed targets for minimum levels of recycled content in EV batteries (for cobalt, lead, lithium, and nickel).²⁶ As part of its 2025 National Packaging Targets, Australia has set specific targets for recycling specific materials in plastic packaging (for instance, 30 percent for polyethylene or PET).²⁷
- **Product-life extension.** France has implemented a law mandating the display of a “repairability index” on electrical and electronic equipment, based on criteria such as the availability and price of spare parts and ease of disassembly.²⁸
- **Extended producer responsibility (EPR).** Sweden and the Netherlands plan to introduce EPR laws that will hold clothing companies responsible for managing textile waste.²⁹ On July 1, 2021, Singapore launched its first nationwide electrical and electronic waste (e-waste) management system based on EPR.³⁰
- **Establishing traceability and accountability.** In January 2022, the state of New York introduced the Fashion Sustainability and Social Accountability Act. If passed, the bill would require global apparel and

footwear companies doing business in New York state and with more than \$100 million in annual revenue to map a minimum of 50 percent of their supply chain, starting with the farms where the raw materials originate through factories and shipping. They would then be required to disclose where in that chain they have the greatest social and environmental impact and make concrete plans to reduce those numbers.³¹

- **Reduced carbon emissions:** The California Air Regulations Board (CARB) has strict regulations regarding motor-vehicle emissions. New CARB regulations are also expected to require truck manufacturers to sell a certain percentage of zero-emission vehicles (ZEVs) out of their total sales.³²

- In future, organizations can expect to see more regulations that affect product design. For instance, the proposed Ecodesign for Sustainable Products Regulation issued by the European Commission aims to make sustainable products the norm in the EU market. The regulation is aimed at the broadest possible range of products and aims to set product-level requirements that not only focus on energy efficiency but also on circularity and on lowering overall environmental and climate impacts due to products.³³ As opposed to scrambling reactively for compliance, proactively designing more sustainable products can help organizations gain a competitive advantage.

61%

Share of organizations that cite regulatory pressures as a top driver of sustainable product design

02

**SUSTAINABILITY
IS NOT AT THE
CORE OF PRODUCT
DESIGN PROCESSES**

Fig.7

Sustainability is not a key component of product design processes for most organizations



The remaining respondents answered, "Don't know."

Source: Capgemini Research Institute, sustainable product design survey, April—May 2022, N=900 organizations.

Our research shows that, despite increasing awareness around sustainability, most organizations are not prioritizing it sufficiently within their product design processes. Only 22 percent of respondents in our survey say that sustainability is a key component of their product design processes (see Figure 7). On one hand, our research indicates that product design has begun to pivot (albeit tentatively) towards sustainability in the past two years. As Figure 7 shows, while only 5 percent of respondents say that their organizations have focused on sustainable product design for more than two years, 17 percent say they have begun to do so in the last two years – a difference of 12 percentage points. However, many organizations apparently remain unconvinced by the sustainability imperative. Despite the urgent need to increase climate action to limit global temperature rise to 1.5°C,³⁴ more than four in 10 (41 percent) either have no immediate plans to do so or do not plan to do so at all.

Fig.8

Most organizations do not conduct regular environmental or social impact assessments



***Environmental impact assessments** refer to Life Cycle Assessments (LCAs) comprising an analysis of all environmental impacts associated with a product throughout its lifecycle (e.g., carbon emissions, pollution, waste, loss of biodiversity, soil erosion/degradation).

Social impact assessments refer to an analysis of all social impacts associated with a product throughout its lifecycle (e.g., forced labor, unsafe working conditions, discrimination based on gender).

Further details regarding scale: Rarely (for less than 10 percent of our products); Sometimes (for 10–50 percent of our products); Often (for 50–90 percent of our products); Always (for more than 90 percent of our products).

Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

Designers have limited awareness of environmental and social impacts across product lifecycles

Awareness of the environmental and social impacts of products is key to minimizing negative impacts and enhancing positive outcomes. Despite this, more than half (51 percent) of respondents in our survey say that product designers in their organizations have limited awareness of such impacts across product lifecycles. We also found that only about one-quarter of organizations in our survey conduct regular (i.e., often or always) environmental or social impact assessments as part of the product design process (see Figure 8). Of these, only eight percent regularly conduct both.

Hitachi Rail, for example, firmly believes that, to reduce negative product impacts, it is important to quantify them and highlight major impact areas. While the organization has been conducting Life Cycle Assessments

(LCAs) according to ISO 14040 and ISO 14044 standards for more than 15 years, more recently it has also implemented a Social Life Cycle Assessment (S-LCA) for its HMU Masaccio train.³⁵

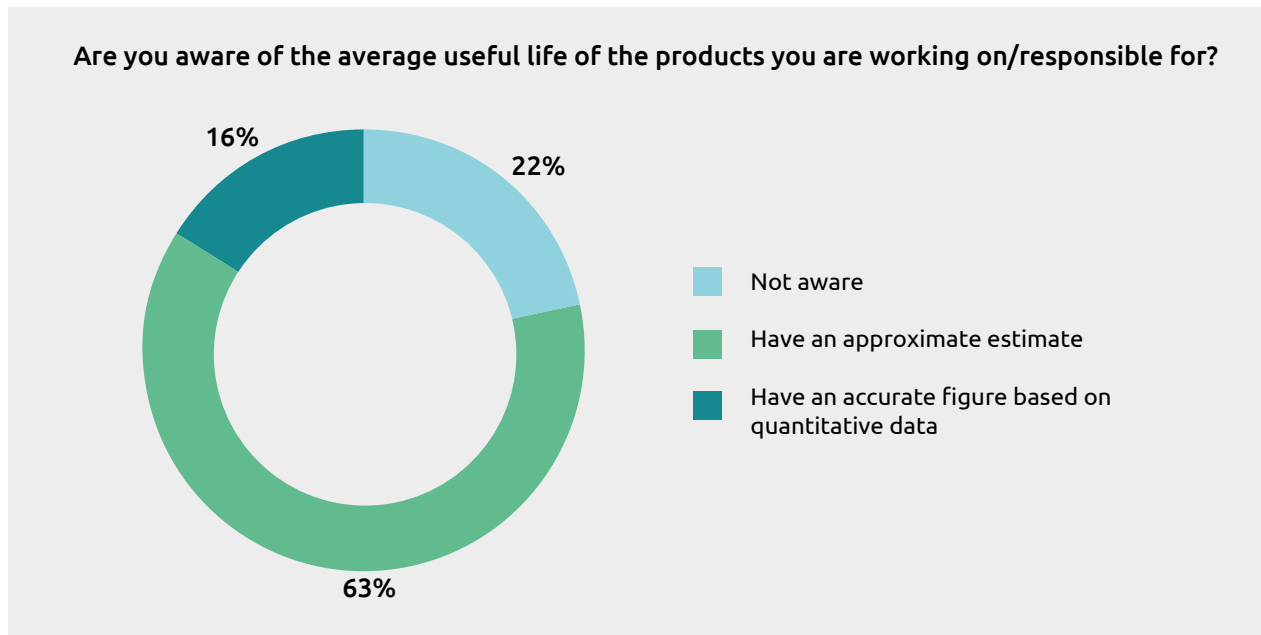
The useful life of a product is a critical input to understanding and accounting for its negative environmental impacts. However, only 16 percent of product designers say they have an accurate quantitative understanding of this. More than six in 10 (63 percent) have only a rough estimate, while 22 percent have no idea of the length of useful life of their products (see Figure 9).

26%

Share of organizations that conduct regular environmental impact assessments as part of the product design process

Fig.9

Most product design executives lack an awareness of the useful life of their products



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

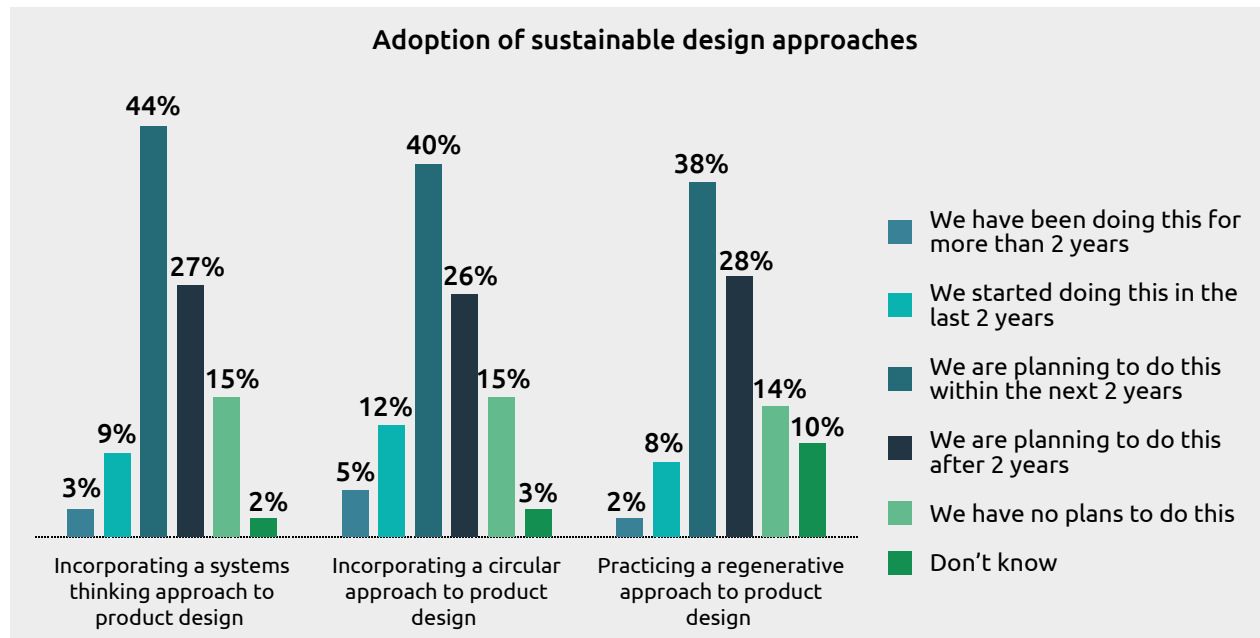
Fig.10

Most organizations are not integrating sustainability into their approaches to product design

Few organizations have adjusted their approach to product design to be more sustainable

To achieve sustainable product design, organizations need to think beyond isolated design problems and consider the system as a whole, mitigating points of social and environmental impact through the entire product lifecycle. Given the pressure on natural resources and the related issues of material depletion and loss of biodiversity, organizations must also adopt a regenerative, circular-design approach that can decouple growth from the consumption of finite resources. However, our research suggests that only a handful of organizations have begun this shift in approach (see Figure 10).

Dr. Caroline Cassagnol, Senior Key Expert Research Scientist at Siemens Technology, emphasizes the need for a mindset shift in product design and development: *“We grew up in a world dominated by the linear economy, and now we need to shift to a circular economy. That requires a completely different mindset. Everything we do must be questioned.”*



Systems thinking to foster sustainability involves looking beyond isolated design problems and considering the whole system in which the product exists, therefore taking into account the product's social and environmental impacts across its entire lifecycle during the design phase.

Circular design thinking involves focusing on practices that are aimed at decoupling growth from the consumption of finite resources, such as reducing, reusing, repairing, refurbishing, remanufacturing, and recycling.

Regenerative approaches involve creating products that renew or replenish systems, rather than depleting them (e.g., by using materials that sequester carbon from the atmosphere).

Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

“We grew up in a world dominated by the linear economy, and now we need to shift to a circular economy. That requires a completely different mindset. Everything we do must be questioned.”



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Dr. Caroline Cassignol

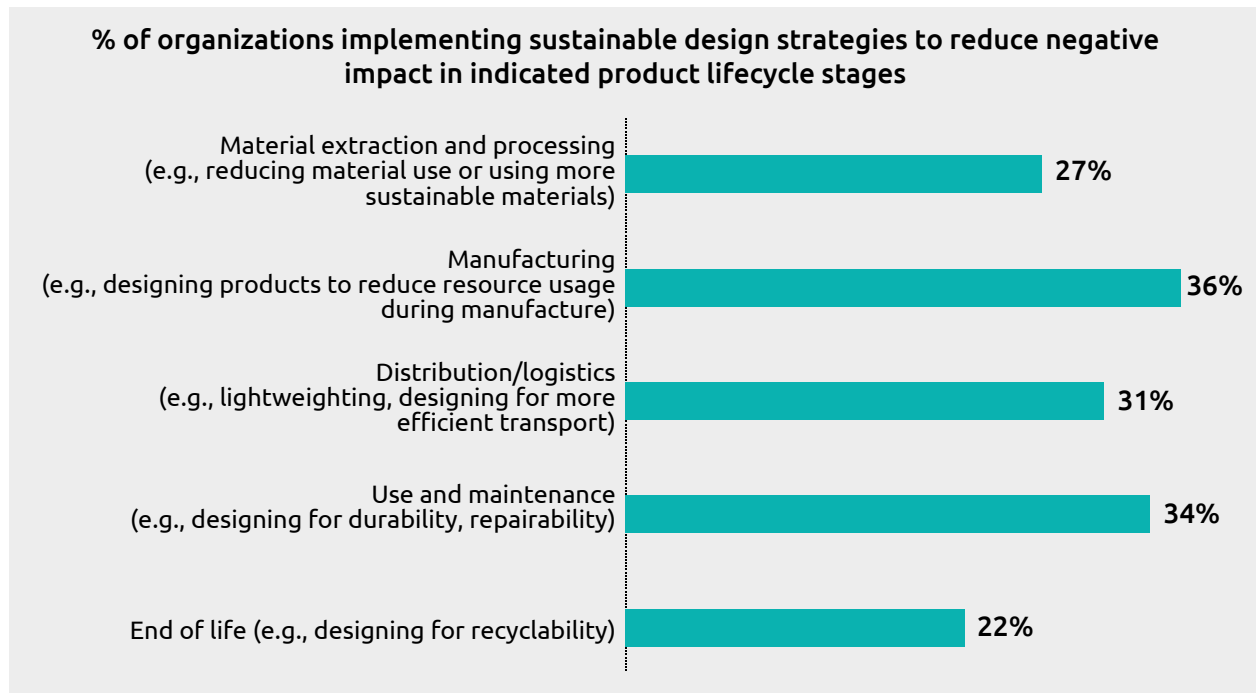
Senior Key Expert Research
Scientist at Siemens
Technology

Only a handful of organizations consider the entire product lifecycle at design stage

The design of the product can significantly affect the sustainability of each product lifecycle stage, and a variety of strategies can be employed to ensure each stage is environmentally and socially sustainable. However, only a few organizations are currently implementing these strategies. Of those that are, most focus on reducing negative impact during the product's manufacturing and use stages, largely ignoring end-of-life management.

Fig.11

Few organizations have adopted sustainable design strategies across the product lifecycle



Percentages averaged over implementation of multiple strategies for each lifecycle stage.
Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.



The strategies outlined in Figure 12 illustrate actions organizations can take to improve product sustainability in each lifecycle stage. These strategies cover the design of physical product attributes – such as the choice of materials, designing for durability, repairability, and easy disassembly – as well as the design of digital components – for instance, strategies such as eco-designing digital products through energy-efficient coding practices and data-transfer mechanisms; designing for evolution to avoid product obsolescence by continuing to provide necessary software updates; and designing products to protect user data privacy and security.

Further, the strategies cover environmental as well as social impacts of products. For instance, strategies focused on environmental impacts include the selection of product materials with lower environmental impacts (i.e., choosing recycled, renewable, recyclable, bio-based, or bio-degradable materials instead of carbon-intensive materials). Strategies that focus on social impact include avoiding conflict materials and designing products to be inclusive. The uptake of all sustainable design strategies is low overall, as Figure 12 shows. For instance, only 27 percent of organizations are selecting materials with lower environmental impacts, and only 21 percent are designing products to be inclusive.

Fig.12

Overall uptake of sustainable product design strategies is low

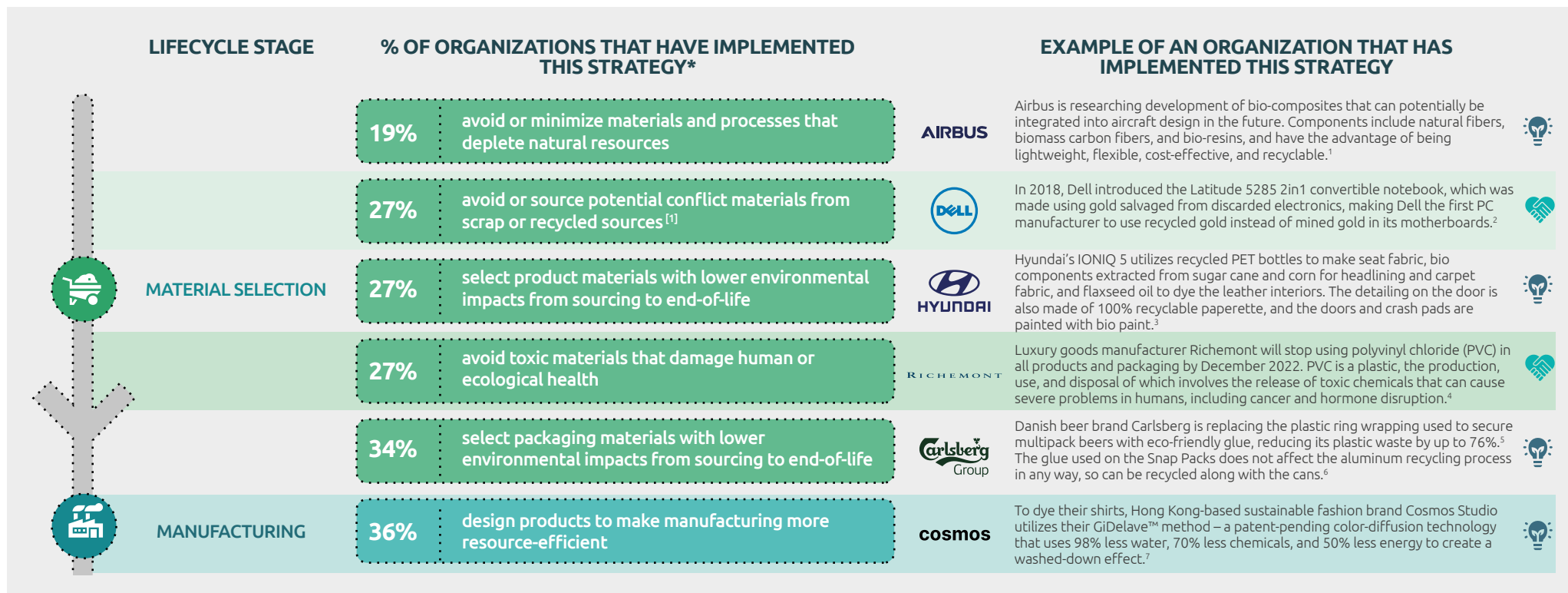


Fig.12

Overall uptake of sustainable product design strategies is low

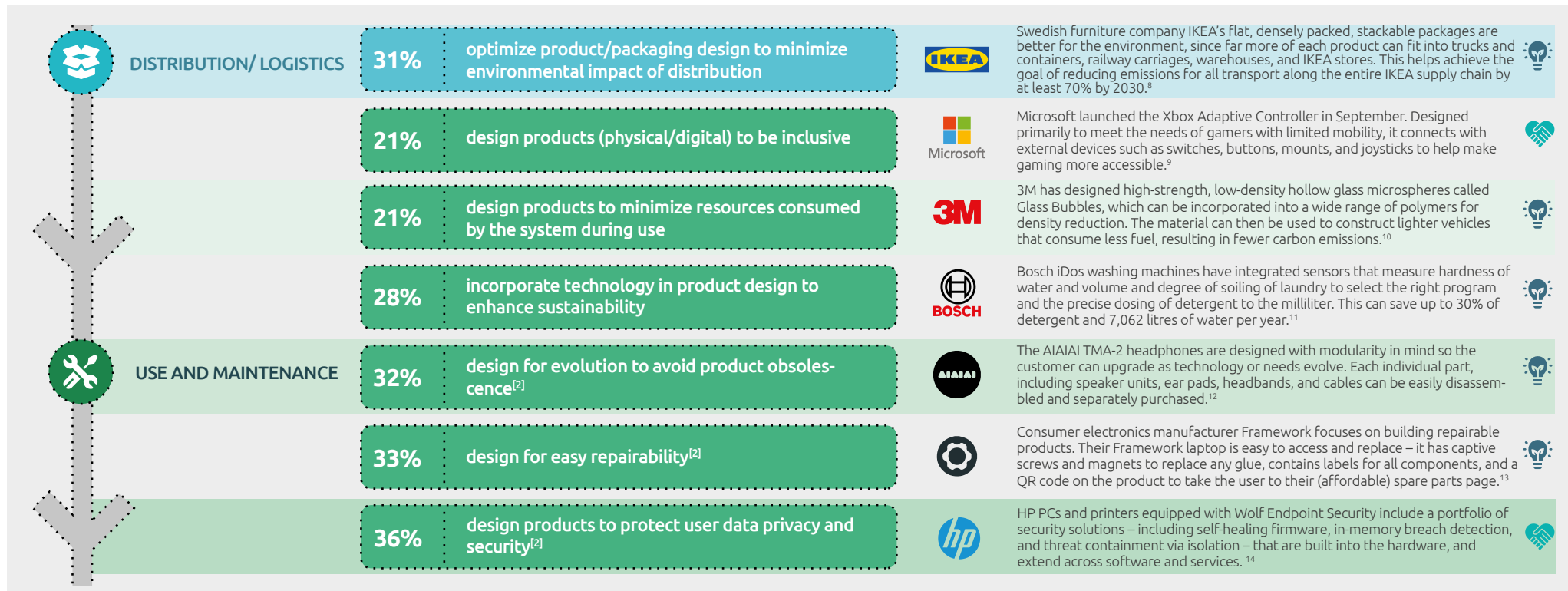


Fig.12

Overall uptake of sustainable product design strategies is low



*Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations. [1] N=710 organizations; Food and beverages, personal and household care products, and furniture excluded since the strategy has minimal relevance to these sectors. [2] N=845 organizations; Food and beverages sector excluded since the strategy has minimal relevance to this sector.

¹ Airbus, “This new class of materials could transform aircraft design,” April 2021.

² Dell, “Technology with a heart of recycled gold,” accessed on May 24, 2022.

³ Hyundai, “IONIQ: Answering the Call for Sustainability,” accessed on May 27, 2022.

⁴ Richemont, “Sustainability: Our Strategy,” accessed on July 7, 2022.

⁵ Carlsberg Group, “Snap Pack. An innovation to reduce plastic,” accessed on May 25, 2022.

⁶ Dezeen, “Carlsberg replaces plastic ring can holders with recyclable glue,” September 2018.

⁷ Cosmos, “Dyeing Innovations,” accessed on June 8, 2022.

⁸ IKEA Museum, “Flatpicks: A flatter furniture future.” accessed on May 25, 2022.

⁹ Microsoft, “Xbox Adaptive Controller: Game your way.” accessed on May 30, 2022.

¹⁰ 3M, “3M Glass Bubbles,” accessed on June 8, 2022.

¹¹ Bosch, “iD0s washing machines,” accessed on July 1, 2022.

¹² AIAIAI, Sustainability: Responsible Design, accessed on May 30, 2022.

¹³ iFixit, “Framework Laptop Teardown: 10/10, But is it Perfect?” July 28, 2021.

¹⁴ HP, “Wherever you are in the world, feel protected with HP wolf security.” accessed on June 8, 2022.

¹⁵ Huawei, “Reducing carbon emissions: Lower power devices are the future,” accessed on July 1, 2022.

¹⁶ The Telegraph, “The best toasters, tried and tested,” March 2019.

¹⁷ Adidas, “Adidas unlocks a circular future for sports with futurecraft.loop: A performance running shoe made to be remade,” April 2019.

¹⁸ Unilever, “Cif innovative at-home refill will remove 1.5 million plastic bottles from UK supermarkets,” July 2019.

¹⁹ Fairphone, “Fairphone 4: SUSTAINABLE. LONG-LASTING. FAIR.” accessed on June 8, 2022.

²⁰ Siemens Healthineers, “The 5-step Quality Process of Siemens Healthineers ecoline systems,” accessed on May 31, 2022.



27%

Share of organizations that select product materials with lower environmental impacts from sourcing to end-of-life

03

**COST CONCERNS
HINDER SUSTAINABLE
PRODUCT DESIGN**

Fig.13

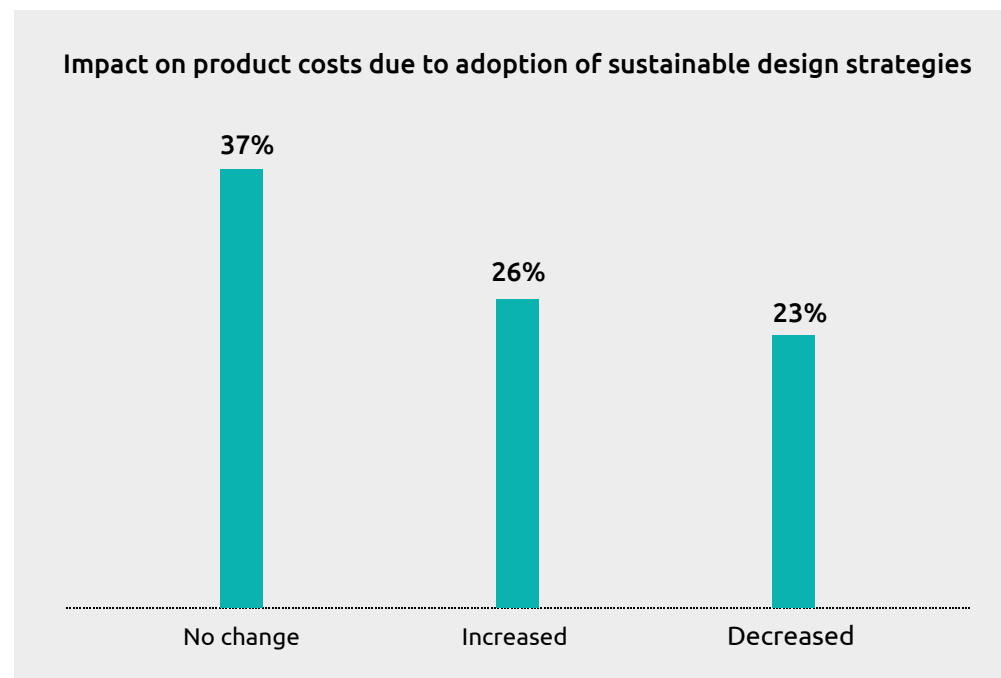
Cost impact of sustainable product design varies on a case-by-case basis

Incorporating sustainable thinking into the early stages of design can offer sustainability benefits across the entire product lifecycle. Nevertheless, progress toward sustainable product design is sluggish. Cost is an overarching issue.

The cost picture is not clear-cut

An increase in costs is often seen as a roadblock in sustainable product design. However, our research shows that sustainable design does not always lead to increased cost (see Figure 12). Close to four in 10 (37 percent) organizations in our research report no change in costs, and close to a quarter (23 percent) report a decrease in costs due to the implementation of sustainable product design strategies.

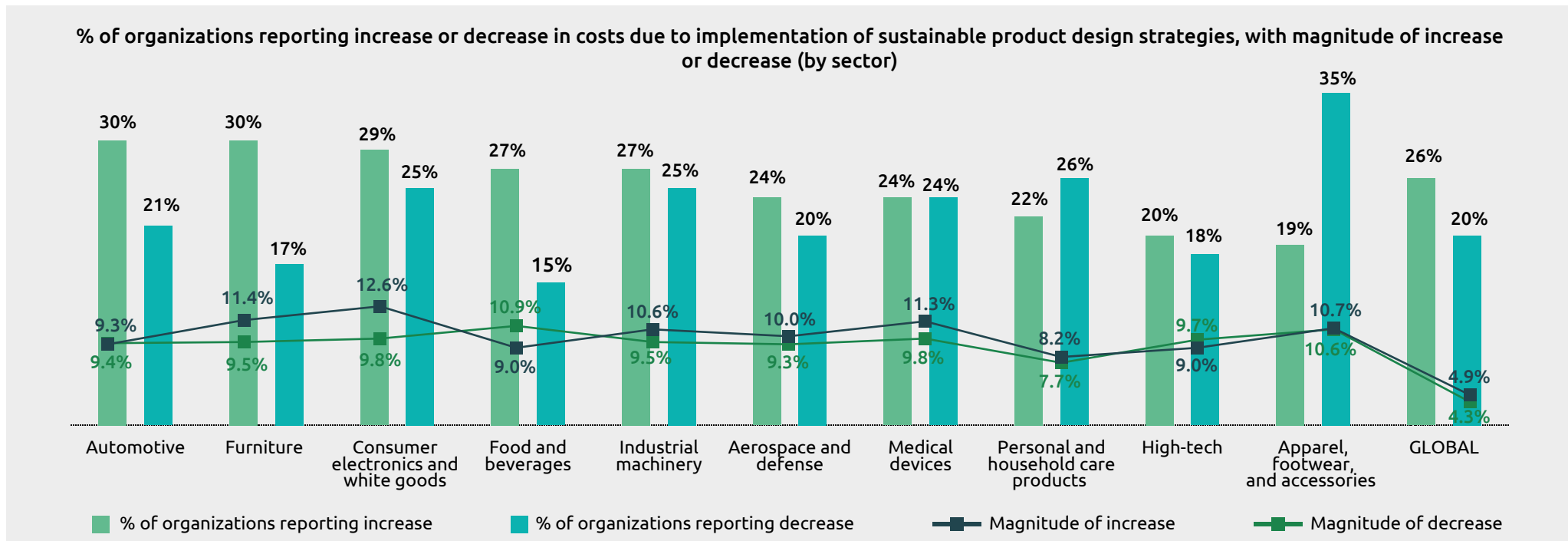
While our research covers a diverse range of sectors, a segment of organizations in each sector reported cost reductions due to sustainable product design initiatives (see Figure 13). Among these, the percentage of organizations reporting a decrease in costs was highest in the apparel, footwear, and accessories sector, while the food and beverages sector reported the highest magnitude of decrease. Conversely, the automotive and furniture sectors have the highest number of organizations reporting an increase in costs due to efforts to incorporate sustainability into product design. The consumer electronics sector reported the highest magnitude of cost increase.



* The remaining respondents selected the “Don’t know” and “Not applicable” options
 Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=889 organizations that have implemented at least one sustainable design strategy.

Fig.14

Across sectors, certain segments are reporting reductions in cost due to sustainable product design initiatives



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=889 organizations that have implemented at least one sustainable product design strategy, of which N=233 reported a resulting increase in costs and N=207 reported a resulting decrease in costs.

Sustainable design strategies offer potential for cost reduction across the value chain

There are several ways in which sustainable design strategies can lead to reduced costs across an organization's value chain:

- **Reduced material costs.** Materials often account for a significant proportion of input costs for organizations. In the EU, for instance, material costs typically account for more than 40 percent of the input costs of manufacturing companies.³⁶ While the use of sustainable material alternatives, such as recycled plastics, could lead to a rise in costs, other strategies, such as “lightweighting”, that reduce material usage can directly result in reduced costs. For example,

Philips' BlueSeal magnet (used in magnetic resonance imaging (MRI) systems) requires just seven liters of liquid helium for cooling, instead of the 1,500 liters that conventional magnets use.³⁷ (There are often shortages of helium in the market; one such shortage pushed up its price from \$930 for a 100-liter container in 2020 to \$2,000 in 2022.³⁸)

- **Reduced manufacturing costs.** In addition to cost savings from reduced material usage, sustainable design strategies can also reduce overall manufacturing costs through increased manufacturing efficiency – for instance, through reduced energy and water consumption or reduced assembly time (e.g., due to reduced part count or greater simplicity of design). IKEA, for instance, has designed a new sofa frame that uses only 13 assembly parts instead of 122. This has resulted in a significant

reduction in water and energy usage.³⁹ Similarly, Nike is developing a range of shoes called Link Axis that is sustainably designed for easy disassembly and recycling, by avoiding the use of glue. Given that the gluing process is time-intensive, avoiding the use of glue has lowered the assembly time for the shoes to eight minutes – a fraction of the average time needed to assemble traditional sneakers.⁴⁰

- **Reduced distribution costs.** Sustainable design strategies focused on optimizing product and packaging design can not only reduce emissions due to transportation, but also result in lower transportation costs. IKEA's use of flat packing, for instance, allows twice as many products to be packed in a single lorry, resulting in the need for fewer lorries overall, and leading to lower emissions as well as lower transportation costs.⁴¹



Cost increases can be outweighed in the long term by economies of scale and other business benefits

When looking at cost increases due to sustainable product design initiatives, organizations should consider the following long-term effects:

- **Lower material costs due to economies of scale.**

The high costs of certain sustainable materials are likely to reduce in the long term as demand rises and economies of scale set in. Currently, gaining access to recycled materials (in the right quantity, quality, or cost), for instance, can be a challenge, given the lack of adequate recycling infrastructure and the small scale at which recycling companies typically operate. However, as focus on sustainability grows, concerns regarding primary resource depletion intensify, and regulations around the use of recycled content become more stringent, demand for recycled materials

can be expected to rise. This in turn is likely to drive economies of scale, eventually bringing down costs. For instance, as recycling systems are implemented across the globe, Unilever expects the cost of recycled plastics to eventually drop below the price of virgin plastics.⁴² Overall, the global waste-recycling services market is expected to grow significantly, from \$55.1 billion in 2020 to nearly \$90 billion by 2028.⁴³

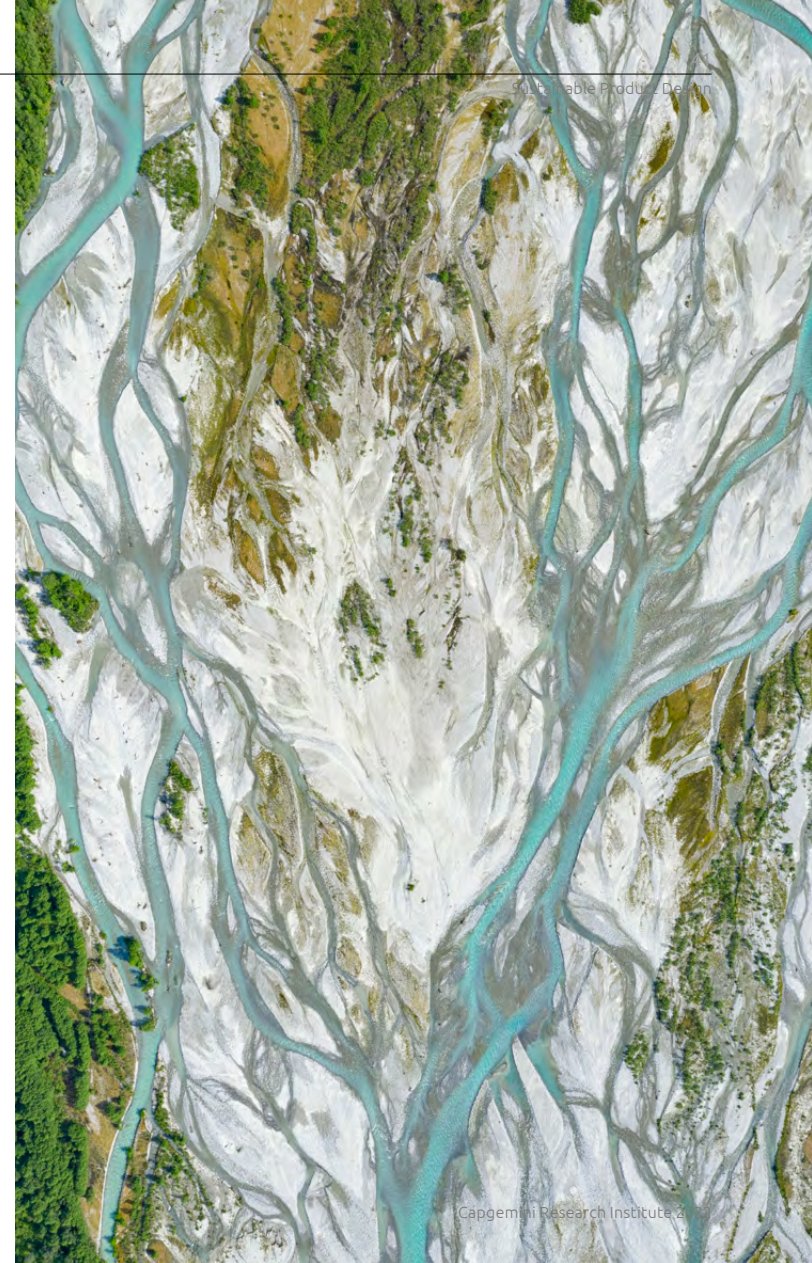
- **Business benefits.** While sustainable design practices may be costlier in the short term, longer-term benefits – such as increased customer satisfaction due to a lengthened product lifespan, reduction in future compliance costs, or even a boost to revenue growth – may outweigh short-term cost increases. Our research also indicates that extra investments in sustainable

product design are paying off: of those organizations that reported an increase in costs, 51 percent say this has already been outweighed by an increase in benefits (e.g., increased revenue/market share, customer loyalty).

- **Risk reduction.** Organizations must also bear in mind that sustainability is crucial to avoiding additional costs in the future. For instance, expansions in carbon-pricing mechanisms could result in increased costs of raw materials, such as metals and plastics. Schneider Electric estimates that a global carbon tax of €50/tonne of CO₂ could add €420 million to its supply chain costs.⁴⁴ Further, according to CDP, a global non-profit that runs an environmental disclosure system,

companies are facing up to \$120 billion in costs from environmental risks in their supply chains by 2026.⁴⁵ Investing in sustainable product design initiatives enables organizations to minimize exposure to such risks by reducing the use of virgin materials and using sustainable options. Sonya Bhonsle, Global Head of Value Chains at CDP, comments:

“With \$120 billion at stake, addressing environmental risks through supply chain engagement is vital for companies to be competitive and resilient in the changing market. Leading companies that address these risks will benefit from lower costs and better reputations. This gives them a more competitive edge today and helps them become more resilient for the economy of tomorrow.”⁴⁶



Lack of sustainable materials and product lifecycle data are other challenges to sustainable product design

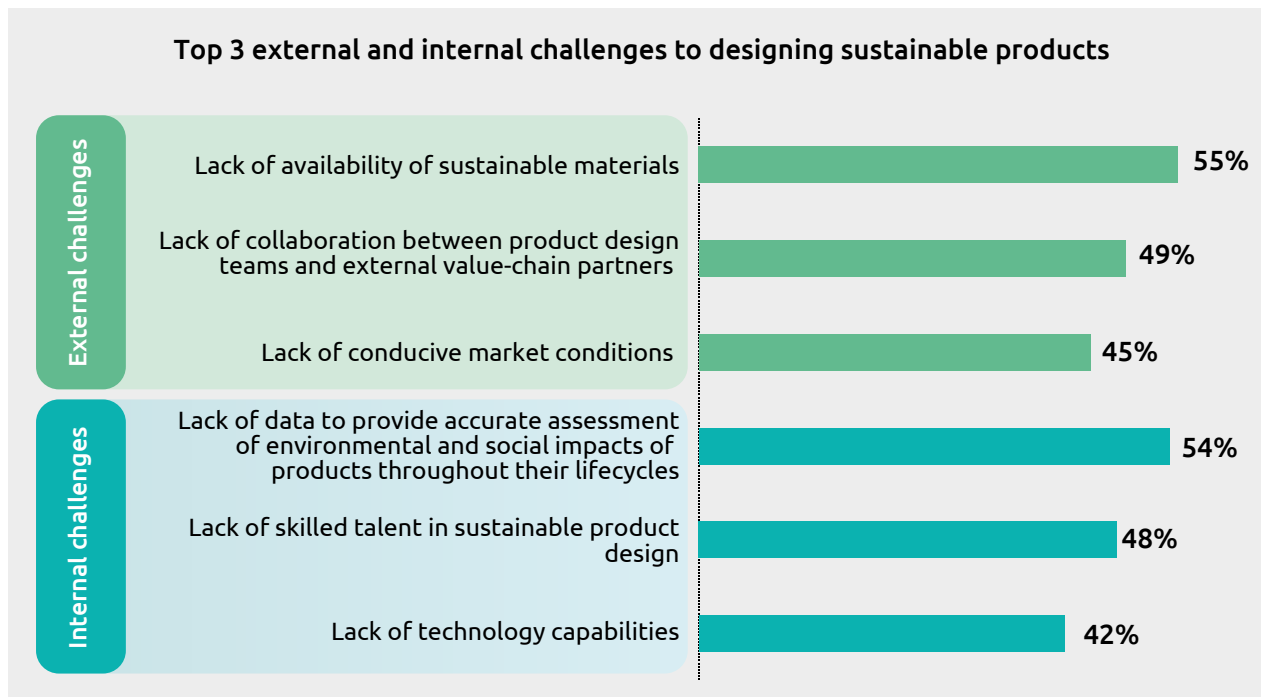
While cost is often the primary hurdle for organizations, it is not the only one. Organizations also need to overcome various external and internal challenges (see Figure 14).

54%

Share of organizations that cite the lack of data on environmental and social impacts of products as a key challenge

Fig.15

Lack of availability of sustainable materials and lack of data to measure impacts are among the top challenges



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

External challenges

Lack of availability of sustainable materials

Lack of availability of sustainable materials is the most significant external challenge (see Figure 15), cutting across sectors. For instance, demand for recycled plastic has been rising and supply is struggling to keep up. In Europe, demand for recycled plastics exceeds the supply potential of local and regional markets.⁴⁷



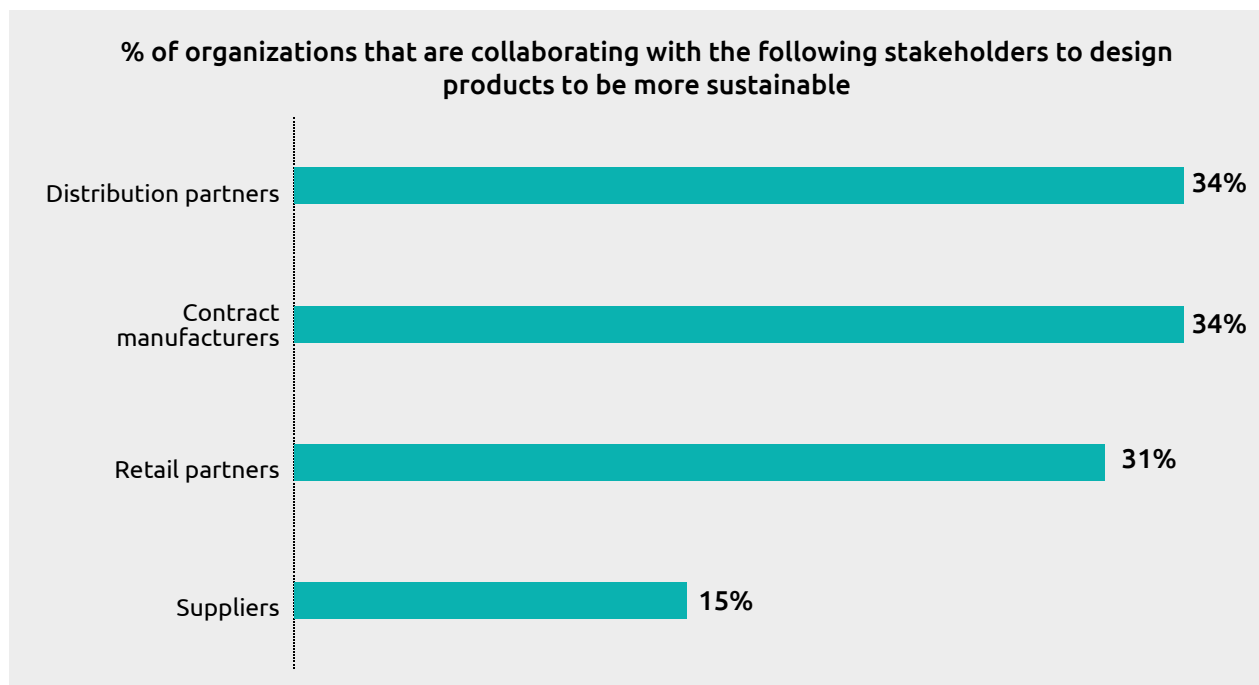
Lack of collaboration between product design teams and external value chain partners

As illustrated by Figure 15, lack of collaboration between product design teams and external value chain partners is also impeding progress. Our research finds that organizations do not collaborate adequately with external stakeholders such as suppliers, contract manufacturers, or distribution and retail partners as part of the product design process (see Figure 16). Collaboration with suppliers, for instance, is key to understanding the challenges associated with sourcing certain materials and identifying alternatives. Collaboration with contract manufacturers enables design teams to better understand the feasibility of implementing design decisions in light of manufacturing constraints. Similarly, collaboration with distribution and retail partners is key to understanding and avoiding unintended consequences lower down the value chain (e.g., the removal of certain types of product packaging, while sustainable, may lead to more waste due to product damage or spoilage).



Fig.16

Organizations do not collaborate adequately with value chain partners to design sustainable products



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

Lack of conducive market conditions

The lack of conducive market conditions is also holding back progress on sustainable product design for 45 percent of organizations. Examples of such conditions include the lack of charging infrastructure holding back progress on electric vehicle (EV) development.

Internal challenges

Lack of data

Respondents indicate that the foremost internal challenge is non-availability of adequate data to provide an accurate measurement of environmental and social impacts of the product across its lifecycle. While many organizations face this issue, Adidas has taken steps to address it. Adidas took it upon itself to measure its core suppliers' emissions on a monthly basis, even offering to help them design frameworks for reduction.

“We cannot wait for perfect information before we act to achieve ambitious decarbonization goals. We must move quickly to reduce emissions significantly along our supply chain,” comments Tracy Nilsson, Formerly Adidas’ Senior Director of Social-Environmental Affairs.⁴⁸

Lack of skillsets

Close to half (48 percent) of organizations cite the lack of skilled talent in sustainable product design as a key challenge. To understand this issue, we investigated the availability of skillsets that are fundamental to sustainable product design, such as the ability to think systemically and to apply circular design approaches. We found that less than one-third (30 percent) of organizations surveyed believe they have sufficient systems thinking skills available in their product design teams. Further, fewer than four in 10 (37 percent) organizations say they have sufficient circular design skills.

Lack of technology capabilities

Advances in technology are opening up numerous opportunities for sustainable product design. These advances are underpinned by two major trends. First, the merging of physical and digital worlds enabled by technologies such as IoT, AI/ML, and digital twins that allow for increased material traceability, and enhanced design and simulation capabilities. Second, advances in the field of bio-innovation that are enabling the discovery of biologically sourced or inspired alternatives for scarce or unsustainable materials and carbon-intensive processes. Figure 16 highlights technologies that can play a critical role in aiding sustainable product design, along with real-world applications of these technologies. However, as seen previously in Figure 15, more than four in 10 (42 percent) organizations cite the lack of technology capabilities as one of their top three internal challenges.

Organizations are notably lacking in capabilities related to the use of LCA tools, which are critical to understanding the environmental impacts of products. Only 44 percent of organizations say they have sufficient

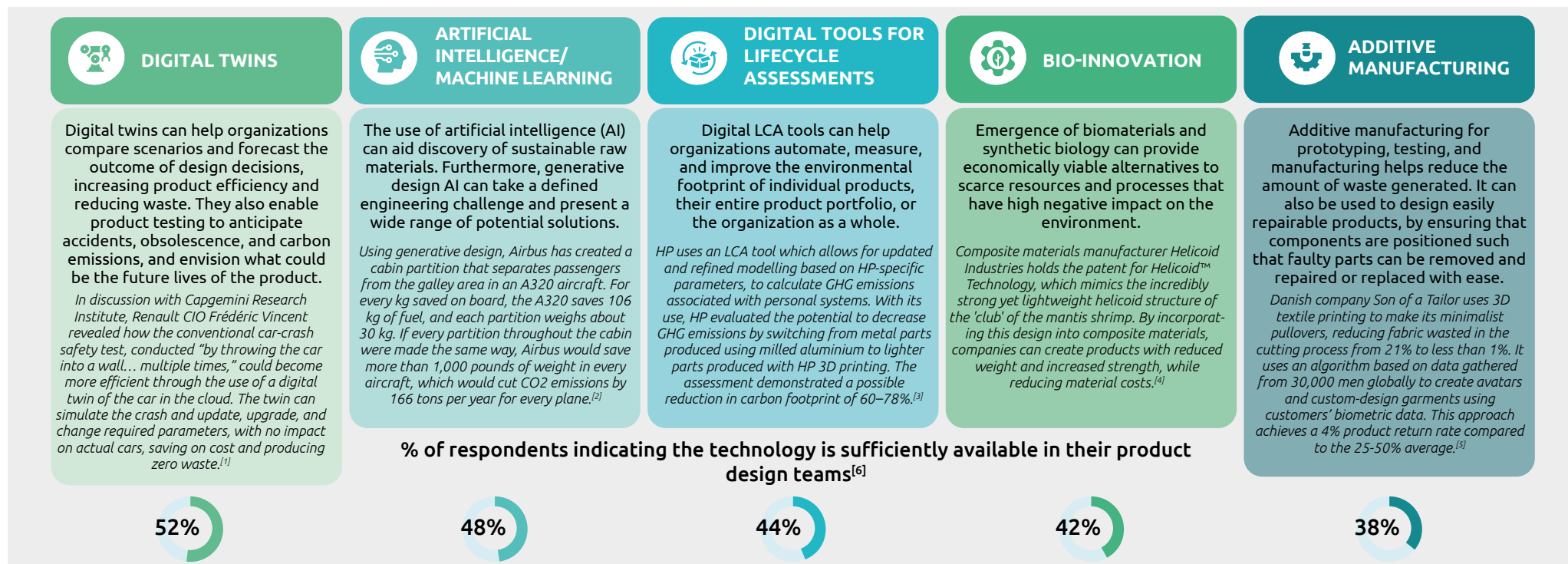


30%

Less than one-third of organizations believe they have sufficient systems thinking skills available in their product design teams

Fig.17

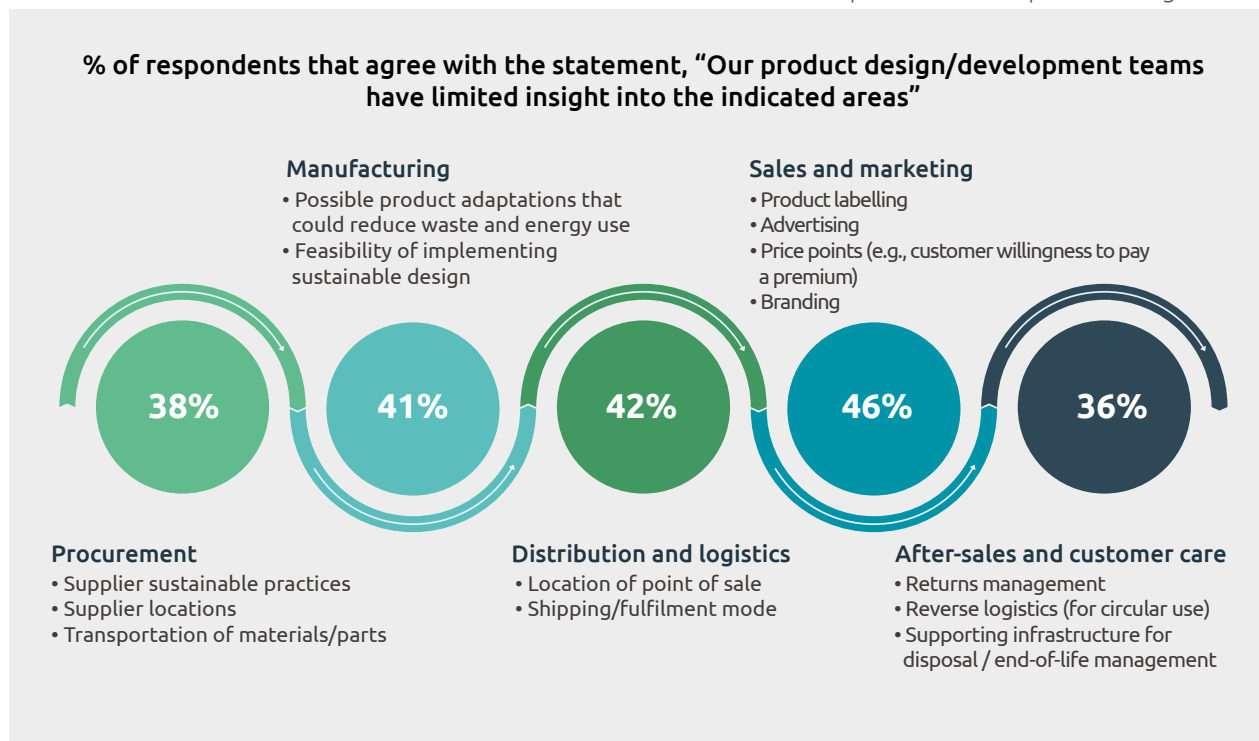
Technology can help design products more sustainably – however, most organizations do not have adequate technology capabilities to support sustainable product design



Sources: ^[1]Capgemini Research Institute, *Conversations for Tomorrow #3, Intelligent Industry: The Next Era of Transformation, Discussion with Renault Group*, 2021. ^[2]Redshift by Autodesk, "What is generative design, and how can it be used in manufacturing?" January 2022. ^[3]HP, "HP sustainable impact report," 2021. ^[4]AskNature, "Strong, durable composite technology inspired by the mantis shrimp: Helicoid Industries," 2020. ^[5]Forbes, "From recycled plastic to 3D printing: More creative sustainable fashion solutions," November 2019. ^[6]Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

Fig.18

Product design teams have limited insight into areas across an organization's value chain that can impact sustainable product design choices



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

capabilities in the use of LCA tools such as GaBi and SimaPro. In contrast, 52 percent of organizations say they have sufficient capabilities in the use of digital twins (see Figure 17). While technologies such as digital twins can certainly aid sustainable product design processes, the lack of LCA capabilities indicates that organizations need to focus more on building certain fundamental capabilities.

Investing in technology will not only help in designing sustainable products, but also in reducing costs and time to market. A senior product engineering executive at a global manufacturing organization says: *"High-accuracy simulation toolsets help bring down the number of prototypes required. The use of simulation techniques has helped us reduce consumption and wastage of plastic and metal. It has also reduced our manufacturing costs, via lower material costs."*

Lack of internal collaboration

Collaboration within the organization (across business units) is also critical. While 29 percent of respondents indicate they are facing challenges regarding internal collaboration around product design, our research also reveals that product design teams often have limited insight into decisions on procurement, manufacturing, logistics, and other areas that can impact design choices (see Figure 18).

An aerial photograph of a large, intricate green maze. The maze is composed of dense, vibrant green hedges or low walls, forming a complex pattern of paths and dead ends. In the center of the maze, there is a small, circular pond. The overall scene is lush and green, with some trees scattered throughout the maze's structure.

04

HOW CAN ORGANIZATIONS SUPPORT SUSTAINABLE PRODUCT DESIGN?

Fig.19

Key actions for organizations

Based on our research, we have identified the following actions that organizations need to take in order to design and deliver sustainable products.

Make sustainability a core design priority and emphasize systems change

Organizations need to ensure that product design teams view sustainability as a core strategic priority. This requires clear, top-down communication regarding the significance of sustainability at an organizational level and the role of product design teams in achieving sustainability goals. Ronald van Harten, Head of Marketing for Fairphone, comments:

“Sustainability is ingrained in our company – it is a vital part of our strategy and our key objective. If that’s not the case, any progress made towards sustainability will be only incremental. It needs to be driven by management. We have a quarterly meeting and the first thing we do is go back to the essence of what we want to achieve, and that is changing the electronics industry, making it better for people and planet.”



MAKE SUSTAINABILITY A CORE DESIGN PRIORITY AND EMPHASIZE THE NEED FOR SYSTEMS CHANGE

- Define clear sustainability goals and objectives for product design teams
- Establish accountability for sustainable product design
- Adopt a data-driven approach to measure impacts across the product lifecycle and identify priorities
- Establish guidelines and provide tools to help product design teams evaluate trade-offs and alternatives
- Invest in upskilling product design teams to enable a mindset shift towards systems thinking and circular design



ESTABLISH PROCESSES AND PARTNERSHIPS ACROSS THE PRODUCT VALUE CHAIN

- Collaborate with stakeholders across the value chain to jointly determine sustainable design decisions, based on impact and feasibility, and invest in partnerships to build new competencies
- Invest in services to enable a shift to a circular economy



MANAGE COSTS THROUGH RE-EVALUATING CONCEPTS AND TAKING A LONG-TERM VIEW

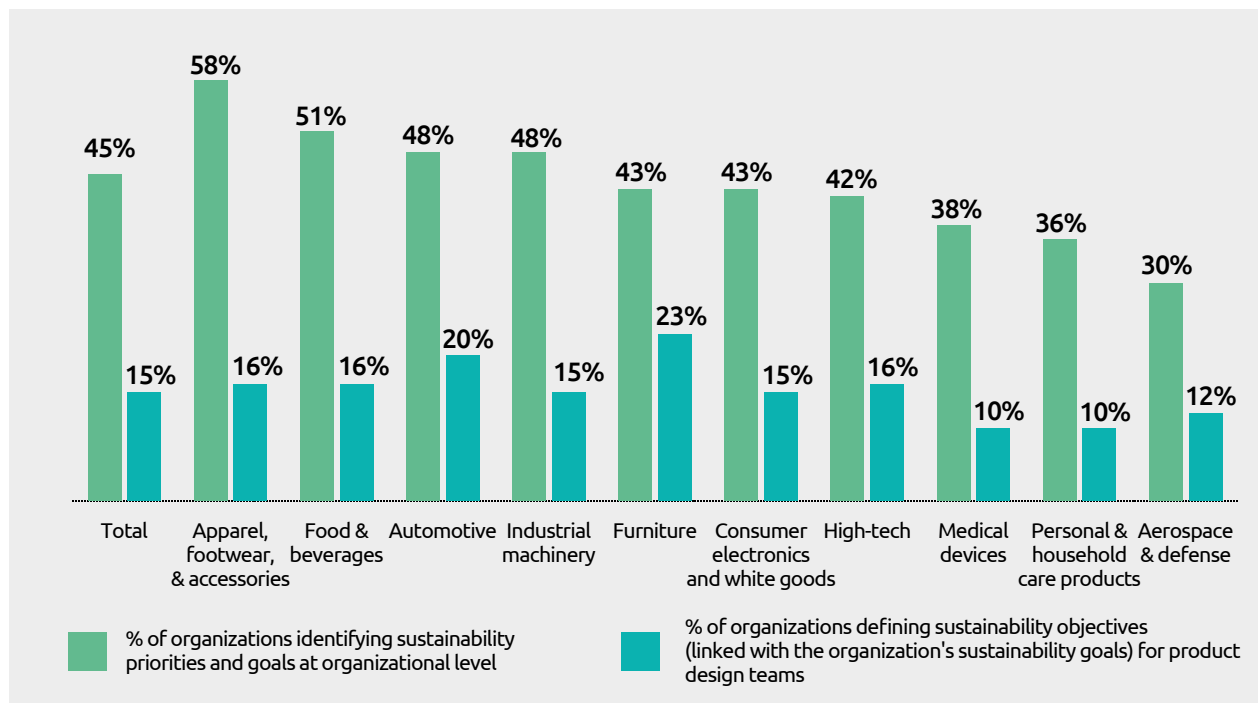
- Adopt a True Cost Accounting (TCA) approach to account for environmental and social costs
- Consider long-term benefits when evaluating investments in sustainable product design
- Educate consumers on the environmental and social costs of products and guide them towards more sustainable choices
- Drive economies of scale through increased investment in infrastructure that supports sustainable action

HARNESS TECHNOLOGY TO SUPPORT SUSTAINABLE PRODUCT DESIGN

Source: Capgemini Research Institute analysis.

Fig.20

Organizations are not defining clear sustainability goals and priorities for product design teams



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

To help achieve this vital prioritization, we recommend the following actions:

- **Define clear sustainability goals and objectives for product design teams**

At 3M, all new products are required to demonstrate how they drive impact for the greater good; 3M refers to this as a product's "Sustainability Value Commitment."⁴⁹

However, most organizations have not established sustainability as a key priority for their product design teams. We found that, while 45 percent of organizations identify sustainability goals and priorities at organizational level, only 15 percent clearly define sustainability objectives for product design teams (see Figure 20).

In order to achieve their sustainability goals, organizations will need to translate their overall sustainability goals into clear objectives and targets for product design teams, along with appropriate metrics to establish accountability and track progress. Figure 21 illustrates this approach with an example.

Fig.21

Organizations need to link their overall sustainability goals with specific goals and metrics for product design teams

When identifying goals and priorities for product design, it is critical that organizations take a systemic approach – looking holistically at the interconnections between the product and the system that it is part of, to identify areas of highest impact that need to be addressed through design interventions.

Dr. Caroline Cassagnol of Siemens says:

“Designers have a key role to play in advancing an organization’s sustainability goals, and they need to be supported in their task. Organizations need to define clear KPIs and targets that they want to achieve in a defined period, so that designers can focus their efforts on those targets. Building a sustainable product can be costly, so there needs to be a strategic decision. Do we want to do it or not? Clear targets and clear decisions concerning the development of a new product are very important.”



Source: Synapse, part of Capgemini Invent.

Fig.22

Responsibility for sustainable product design resides in varied functions, depending on the organization



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

- **Establish accountability for sustainable product design**

To ensure that sustainable product design initiatives receive adequate management attention, organizations will also need to establish clear accountability for them – with clear leadership roles backed by appropriate metrics and performance incentives.

- **Adopt a data-driven approach to measure impacts across the product lifecycle and identify sustainable product design priorities**

Measuring the environmental and social impacts of products across the product lifecycle is critical to driving systems change.

Organizations will need to conduct regular product impact assessments – spanning the entire product lifecycle – to identify high-impact areas. Philip White, associate professor of industrial design and senior sustainability scientist at Arizona State University, stresses the need for this: *“It is critical that organizations conduct product impact assessments early on in the design process. Environmentally sustainable product design requires stepping back*

and understanding product impacts before designing products. It needs to be done systemically and it requires upper management support. Organizations do not do this on a regular basis, but it's absolutely needed."

Crucially, organizations should conduct environmental impact assessments (i.e., LCAs) as well as social impact assessments, in order to consider product impacts holistically and avoid any unintended negative consequences through product design choices. Results of product impact assessments should then be used to inform design decisions.

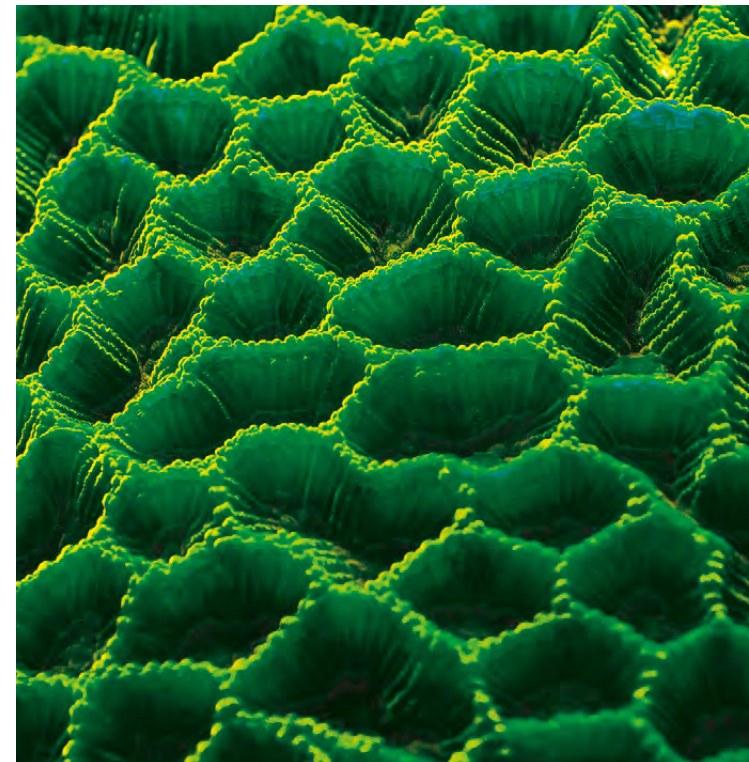
Ronald van Harten of Fairphone comments:

"Where it starts is understanding your whole value chain, including your supply chain and what the customer does with your product. We have a dedicated impact team of 7-8 people working to get more insight into these areas. Once we have identified the issues, we look at what we can do where in the chain to address them, often that is with product design."

To improve the quality of impact assessments, L'Oréal is participating in the EcoBeautyScore Consortium, which brings together 36 companies and professional

associations from the cosmetics industry to establish an industry-wide environmental impact assessment standard and scoring system for cosmetics products.

Further, robust product lifecycle assessments require accurate, quantitative impact data. Collaboration with value chain partners such as suppliers will be key to building visibility into environmental and social impacts across the product lifecycle. Technologies such as digital twins and blockchain also have key roles to play in tracking product impacts. For instance, Siemens, through its Green Digital Twin initiative, is developing a digital twin of its supply chain, aimed at assessing the amount of carbon emitted by every component used in Siemens' products. Siemens has also developed a solution called SiGREEN – based on digital twin and blockchain technology – that enables product carbon footprint data to be securely shared among value chain partners.⁵⁰ Dr. Gunter Beiting, Senior Vice President Manufacturing & Head of Product Carbon Footprint/SiGREEN, Siemens AG, says: *"Verifiable primary data-based PCF (Product Carbon Footprint) connected along the supply chain enable partners to take action where it's most efficient. This requires cross-company collaboration and exchange that protects all partners' full data sovereignty."*⁵¹



- **Establish guidelines and provide tools to help product design teams evaluate trade-offs and alternatives**

Organizations should also develop guidelines to help product designers select appropriate sustainable design strategies and evaluate trade-offs between sustainability and other design parameters, such as performance, quality, and cost. Matilda Leivas, Product Engineering Leader at IKEA, says: *“You need to start at the conceptual level and then boil it down to something that you can actually implement and measure. We have identified a set of seven design principles. These include using renewable or recycled materials, and designing for recycling, standardization, disassembly, reassembly, adaptability, care, and repair. The design principles have been translated into criteria that can be applied at product level, and be further broken down into actual product and material requirements.”*

In addition, organizations should provide product designers with tools to help them evaluate alternatives. Dr. Caroline Cassagnol of Siemens says: *“Organizations should invest in tools to help designers make informed decisions between different design alternatives. We need to incorporate information*

concerning environmental impacts and circularity metrics into the design phase, so that designers have direct access to information on the consequences of their design decisions.”

- **Invest in upskilling product design teams to enable a mindset shift towards systems thinking and circular design**

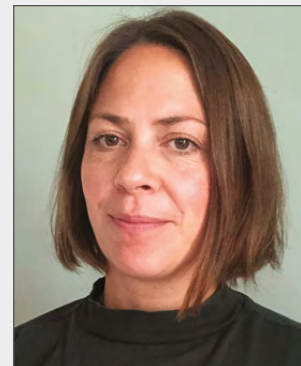
Delivering transformative change starts with a shift in mindset. Organizations will need to ensure that product design teams adopt a systemic and circular approach to product design in order to look at product impacts (both environmental and social) holistically across the product lifecycle and decouple growth from the use of finite resources. However, as we saw earlier, most organizations lack skills in systems thinking and circular design thinking that are fundamental to sustainable product design. In addition, organizations lack sufficient capabilities in key technology areas such as the use of LCA tools that are essential for measuring and accounting for product impacts. Organizations will, therefore, need to invest in hiring and upskilling initiatives aimed at building necessary skillsets within their product design teams. However, our research shows that only 30 percent of organizations have increased their headcount for sustainable product

design initiatives and only 28 percent are currently upskilling their product design teams (see Figure 23).

Cisco has set a target to ensure that 100 percent of its new products and packaging will incorporate circular design principles by 2025. As part of its efforts towards meeting this goal, Cisco launched its “Circular Design Principles” in 2020 and now bases its design training on these. Cisco has also integrated these principles into standard design tools.⁵²

Matilda Leivas of IKEA highlights a three-step approach to upskilling internal teams on sustainable product design: *“We have been working on a competence development package, where we started with awareness trainings about our circular design principles and KPIs and how those will be integrated into our processes and ways of working for everyone involved in product development. The next step was to have trainings on different subjects related to our circular design principles – for instance, material selection, standardization, affordability, and prolonging product life. The third step consists of workshops with product development teams where we dive deeper into their projects and discuss what specific design principles and criteria mean for their products.”*

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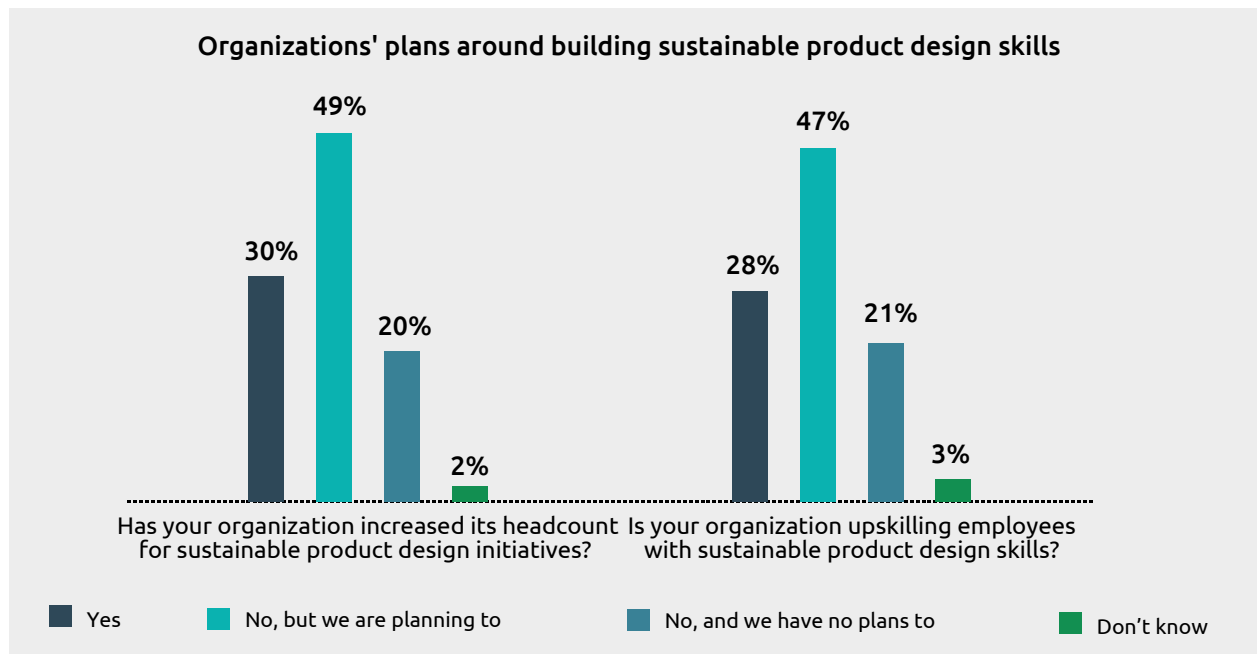


Matilda Leivas

Product Engineering Leader
at IKEA

Fig.23

Organizations must do more to build their sustainable product design skillsets



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

Establish processes and partnerships across the product value chain

A holistic approach to ensuring that a product is sustainable across its lifecycle requires inputs from multiple internal and external stakeholders. Product design processes need to be closely integrated with the rest of an organization's value chain.

According to Dr. Jonathan Chapman, Professor and Director of Doctoral Studies at Carnegie Mellon University's School of Design, *"Design-led systems change requires a strategic way of thinking about a process, where you understand the complex nature of the problem space, and then work with different stakeholders to develop a vision of a future that you want to transition to."*

- **Collaborate with stakeholders across the value chain**

- **Jointly determine sustainable design decisions**


In order to understand the environmental and social impacts of products and the feasibility of design decisions, product design teams must collaborate closely with internal functions and external stakeholders, such as suppliers and partners. A collaborative approach will also reduce time to market and mitigate the cost of building prototypes by identifying issues earlier in the design process and thereby reducing the number of design iterations required. However, our research shows that only 16 percent of organizations collaboratively develop their sustainable product design strategies to ensure alignment with internal functions.

Organizations should consider setting up cross-functional teams to determine sustainable product design decisions. We look at examples of this approach below:

“Design-led systems change requires a strategic way of thinking about a process, where you understand the complex nature of the problem space, and then work with different stakeholders to develop a vision of a future that you want to transition to.”



- Dr. Jonathan Chapman,
Professor and Director of Doctoral
Studies at Carnegie Mellon University's
School of Design

- 
- Nicolas Veauville of Philips Domestic Appliances highlights Philips’s collaborative approach to sustainable product design: *“We have a cross-functional assessment team with representatives from R&D, consumer marketing, product development, legal, manufacturing, procurement, logistics, innovation, and sustainability. This team gets together right in the beginning to discuss the project scope and eco-design requirements needed to design and build a product.”*
 - In 2021, as part of its commitment to using low-carbon, circular, and safer materials, Schneider Electric set up a cross-functional team of experts from its procurement, R&D, and environment teams. The team of experts worked closely with Schneider Electric’s suppliers to define the attributes of “green” materials (i.e., materials with a lower carbon footprint). For instance, thermoplastics were categorized as green if the supplier could provide evidence of a minimum level of recycled or bio-based content, among other criteria. Similarly, green attributes were identified for steel and aluminum.⁵³
 - **Invest in partnerships to build new competencies**
To develop sustainable products, organizations should also invest in building partnerships with their wider ecosystem (including suppliers, partners, research centers, startups, competitors, and technology incubators) to accelerate product innovation, create new services, and enable “industrial symbiosis” (the practice of using waste generated by one organization as a resource for another). We look at examples of each of these below:
 - **Accelerate product innovation.** Nike is partnering with US-based biotech company Newlight Technologies to explore the use of AirCarbon – a carbon-negative biomaterial produced by micro-organisms from the ocean – that can be used as a carbon-negative substitute for plastic and leather. Noel Kinder, Chief Sustainability Officer at Nike, highlights the need for partnership to drive sustainable product design: *“Materials account for 70 percent of Nike’s total carbon footprint, and we’re accelerating our efforts and exploring new opportunities in this space because, in the race*

against climate change, we can't wait for solutions, we have to work together to create them.”⁵⁴

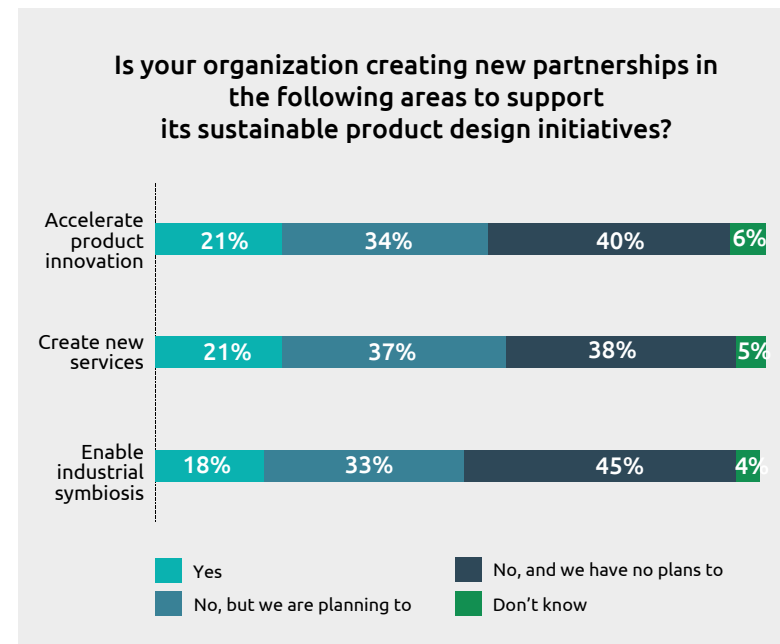
- **Create new services.** US-based apparel brand The North Face has partnered with The Renewal Workshop – a startup that provides professional cleaning and repair services for damaged, returned, or used clothes. Refurbished clothing is resold on the organization’s re-commerce platform, The North Face Renewed.⁵⁵
- **Enable industrial symbiosis.** Ford Motor Company partnered with McDonald’s to use coffee chaff (waste produced during the coffee-roasting process) to make car parts such as headlight housing. The resulting parts were found to be 20 percent lighter and used 25 percent less energy during molding, while also reducing the amount of coffee waste (it is estimated that McDonald’s produces more than 62 million pounds of coffee chaff a year, all of which used to go to landfill).⁵⁶

However, currently only about 20 percent of organizations are creating new partnerships to support their sustainable product design initiatives (see Figure 24).

Ronald van Harten highlights Fairphone’s holistic approach to product design: *“An average smartphone contains more than 50 different types of metals. We chose 14 focus materials where we think we can make the most impact. For these materials we are working toward making the whole supply chain – from the mine to inside of the phone – more people- and environment-friendly. In addition, we are constantly thinking about what we can change in the product design to make it better for the environment. How can we make sure we only use recycled plastics? What about the packaging? Where does the paper and ink we use come from? We keep raising the bar and often if it means that the cost is higher, we accept it.”*

Fig.24

Few organizations are creating new partnerships to support sustainable product design



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

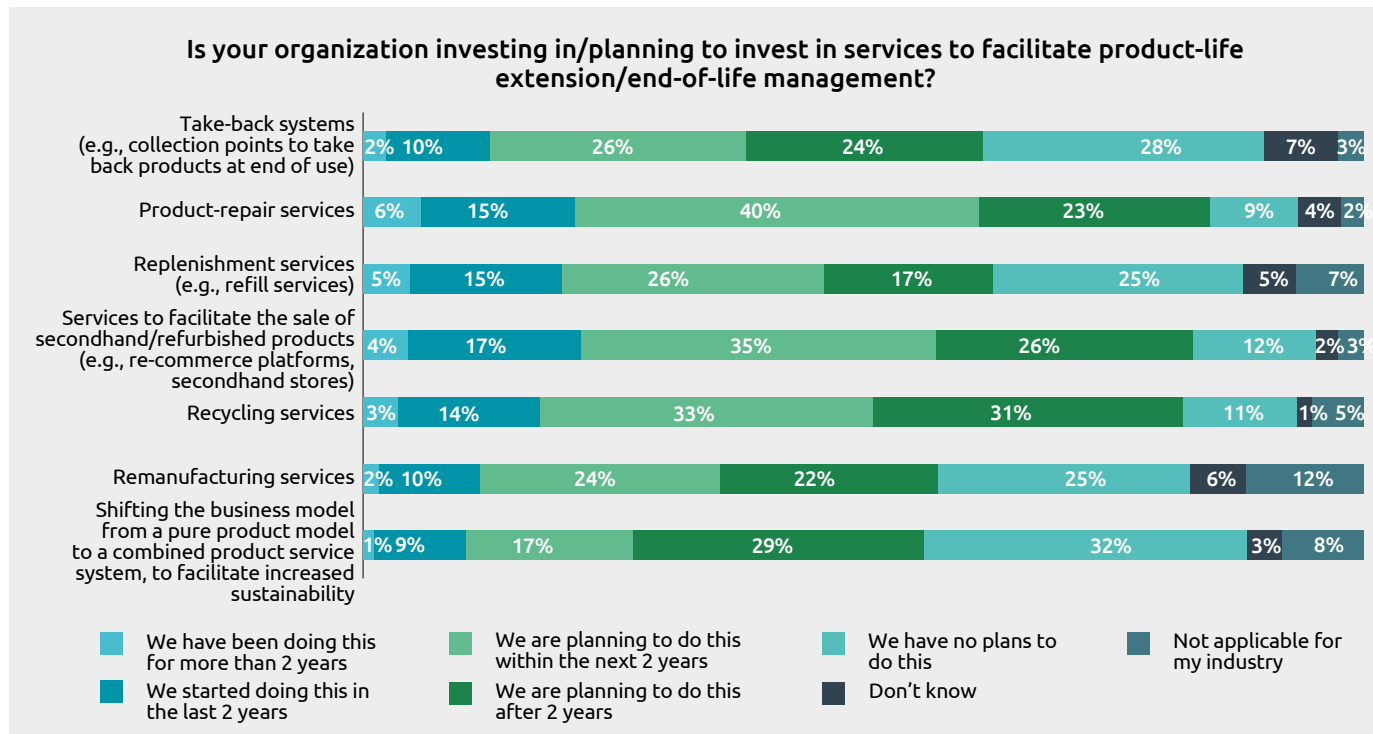
Fig.25

Organizations are doing little to invest in product life extension or responsible end-of-life management

• Invest in services to enable a shift to a circular economy

To ensure lifecycle sustainability, design processes should aim to close the loop of product and material flows. In addition, organizations need to invest in infrastructure and services to facilitate product-life extension and end-of-life management. IKEA, for instance, has launched a buyback program offering customers store credit in exchange for used furniture.⁵⁷ Patagonia offers free repairs, as well as self-repair guides and kits.⁵⁸ However, few organizations are investing in such services (see Figure 25).

In addition to investing in services, organizations should also consider developing Digital Product Passports (DPPs) to drive circularity. DPPs are digital tags encapsulating a range of product-related data (e.g., data on materials, carbon footprint, repairability, disposal instructions) that can be useful to stakeholders across the organization's value chain. For instance, data on the types of materials used in a product is a valuable input for waste recyclers. Data on product carbon footprint, in contrast, can help consumers take more informed purchase decisions. The European Commission's proposed Ecodesign for Sustainable Products Regulation also makes DPPs a priority.⁵⁹



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

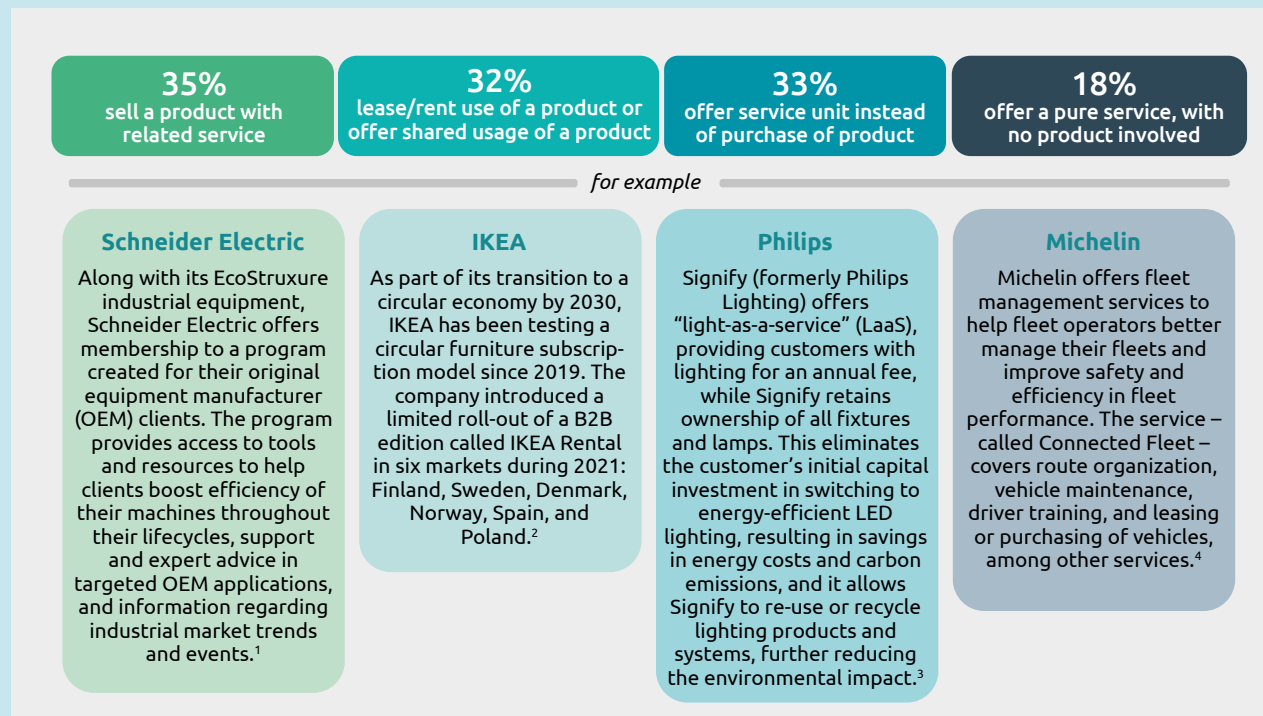
Driving sustainability by pivoting from products to service-based business models

Beyond building sustainable products, organizations also need to rethink their business models using a sustainability lens. Shifting from product to service-based models (“servitization”), when underpinned by the right metrics, can be a key step towards sustainability. For instance, service-based shared-usage models discourage sole ownership of products and, as a result, reduce the number of products created, used, and disposed of. However, our research shows that only 10 percent of organizations are shifting their business models from a pure product model to a combined product service system, while 17 percent plan to do so in the next two years (see Figure 25).

Organizations may invest in offering various levels of product service systems, from selling products with a related service, to shifting to pure service-based models (see Figure 26).

Fig.26

Organizations offering or planning to offer combined product service systems can do so in various stages



Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=243 organizations offering/planning to offer combined product service systems.

¹Schneider Electric, “Original Equipment Manufacturers.” ²CNBC, “Why you might be leasing not buying your next couch,” January 2022. ³CircularX, “Signify – Light-as-a-Service.” ⁴Michelin, “Michelin Connected Fleet.”

Manage costs through re-evaluating concepts and taking a long-term view

As we saw earlier, cost concerns are holding back organizations from developing sustainable products. Below, we look at some of the ways in which organizations can change their perspective on costs.

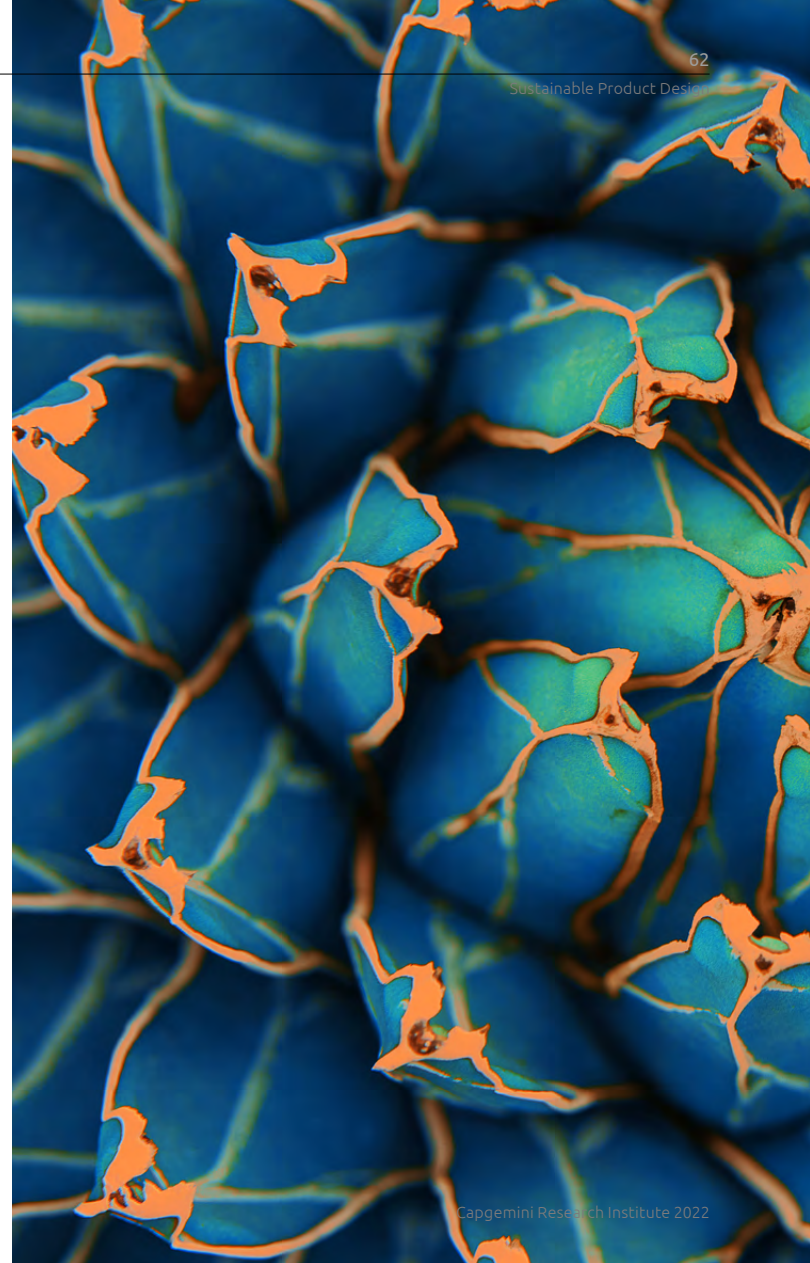
- **Adopt a True Cost Accounting (TCA) approach to account for environmental and social costs**

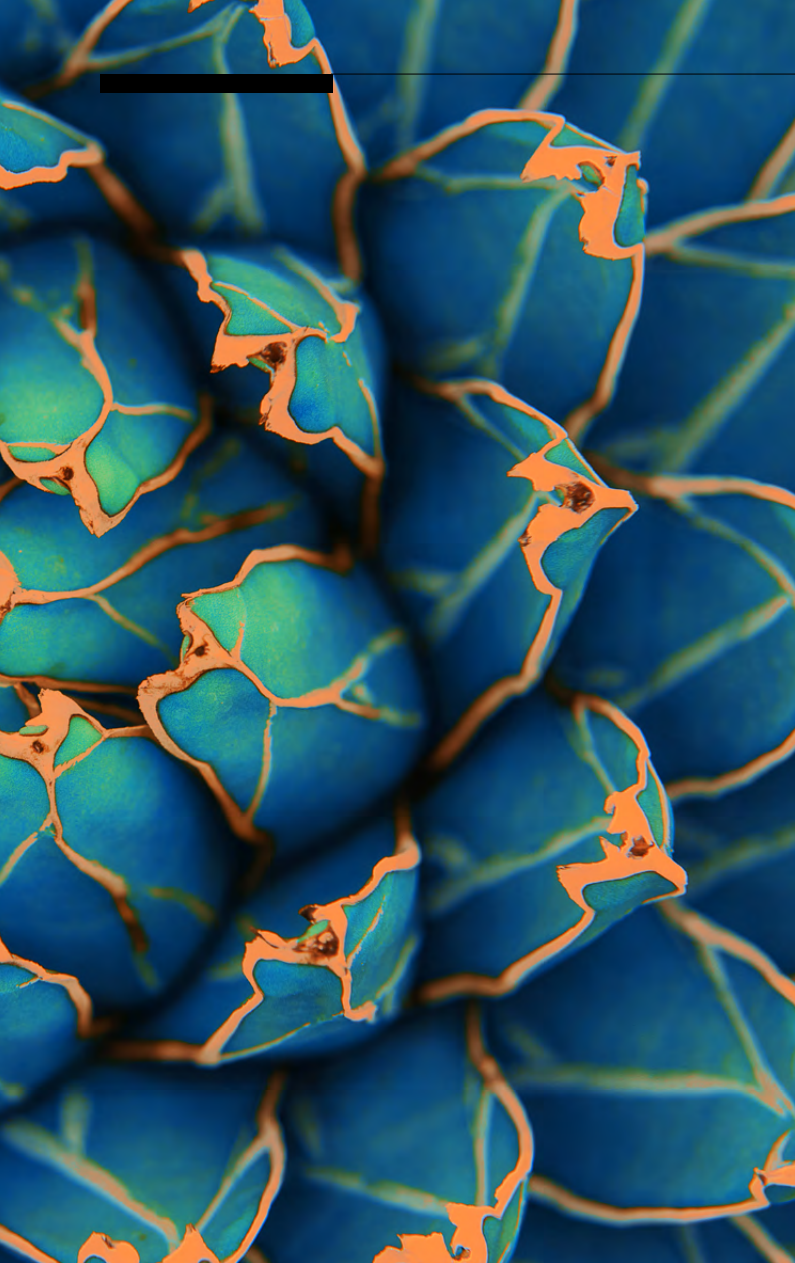
Environmental and social costs must be considered alongside economic costs of sustainable product design initiatives. Organizations should adopt a TCA approach to build a picture of true product costs. While there are various impacts that organizations should consider when determining true product costs – such as the impact on communities, social wellbeing, climate change, biodiversity, forest cover, and soil and water quality – accounting for costs associated with a product’s carbon footprint is a feasible starting point, given that data on carbon emissions is relatively easier to source or estimate compared to data on other environmental and social impacts.

Since 2017, Philips has been using a digital platform to measure its environmental footprint, even assigning it a monetary value through the environmental profit & loss account methodology.⁶⁰ Based on the results, Philips has redesigned its existing products to be more sustainable, in alignment with its EcoDesign guidelines.⁶¹

- **Consider long-term benefits when evaluating investments in sustainable product design**

As seen earlier, sustainable design initiatives offer opportunities for cost reduction across the value chain by enabling reduced material costs, increased manufacturing efficiency, or reduced transportation costs. These cost-reduction opportunities may even outweigh upfront costs. For instance, since 2008, Unilever has cut costs by \$1.5 billion through sustainable sourcing; and its executives believe upfront sustainability investments very often result in long-term savings.⁶² Unilever CEO Alan Jope believes sustainability is *“a benefit where, sometimes, there are initial cost premiums that we need to work our way through.”*⁶³ Initial cost premiums can also be outweighed by benefits such as increased revenues and customer satisfaction. Further, sustainable design initiatives can protect organizations from exposure





to market threats such as resource scarcity and from the risk of regulatory non-compliance. It is critical therefore that organizations view investments in sustainable product design efforts through a long-term lens.

- **Educate consumers on the environmental and social costs of products and guide them towards more sustainable choices**

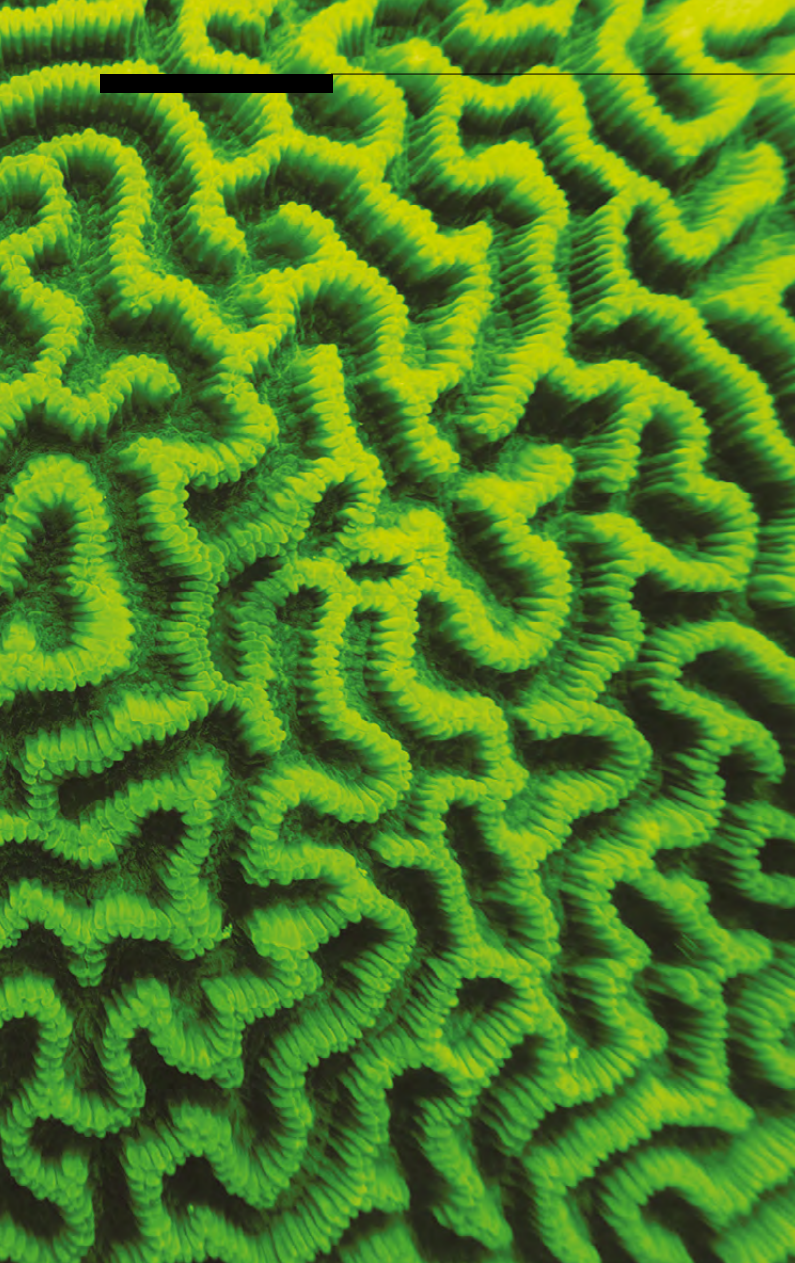
We recommend the following approaches:

- Develop standardized product labels, similar to nutritional labels, that clearly indicate the environmental and social costs of creating the product. Providing carbon-footprint data on product labels can be a feasible starting point. Organizations should also consider declaring product environmental impact data, according to ISO 14025:2006 norms, in order to help consumers make more informed purchase decisions.
- Use product certifications and scores to build trust regarding the authenticity of sustainable products.

Examples of such certifications include Cradle to Cradle Certified® and Climate Neutral Certified.⁶⁴

- Educate customers in using products mindfully – for instance, using products in ways that conserve energy and water – by raising awareness and displaying clear instructions on product packaging.
- Educate consumers on the total cost of ownership of sustainable products, as higher upfront costs could be outweighed by extended product lifespans.
- Build awareness regarding the carbon impact of delivery options and, where possible, discourage customers from opting for immediate shipment options that have a higher carbon impact.

Philip White of Arizona State University highlights the importance of communicating product sustainability information to customers in easily accessible formats: *“Product sustainability declarations can be detailed and complex. Companies should have simplified versions of the declarations – in the form of ratings, for example – to communicate this information more effectively to customers.”*



- **Drive economies of scale through increased investment in infrastructure that supports sustainable action**

Availability and costs of sustainable materials are a challenge for organizations today and there is a need for greater collaboration among industry participants to drive economies of scale. Unilever North America is investing \$15 million in a private equity fund to boost the growth of companies in the recycling value chain. The investment will provide Unilever with access to recycled plastics processed by the companies, helping it to move closer to its goal of halving its use of virgin plastic by 2025.⁶⁵

Harness technology to support sustainable product design

Technology can significantly aid the process of sustainable product design. However, few organizations are harnessing technology adequately – only 16 percent, for instance, conduct LCAs using digital tools, and only 18 percent use AI/ML to identify optimal raw materials (see Figure 27).

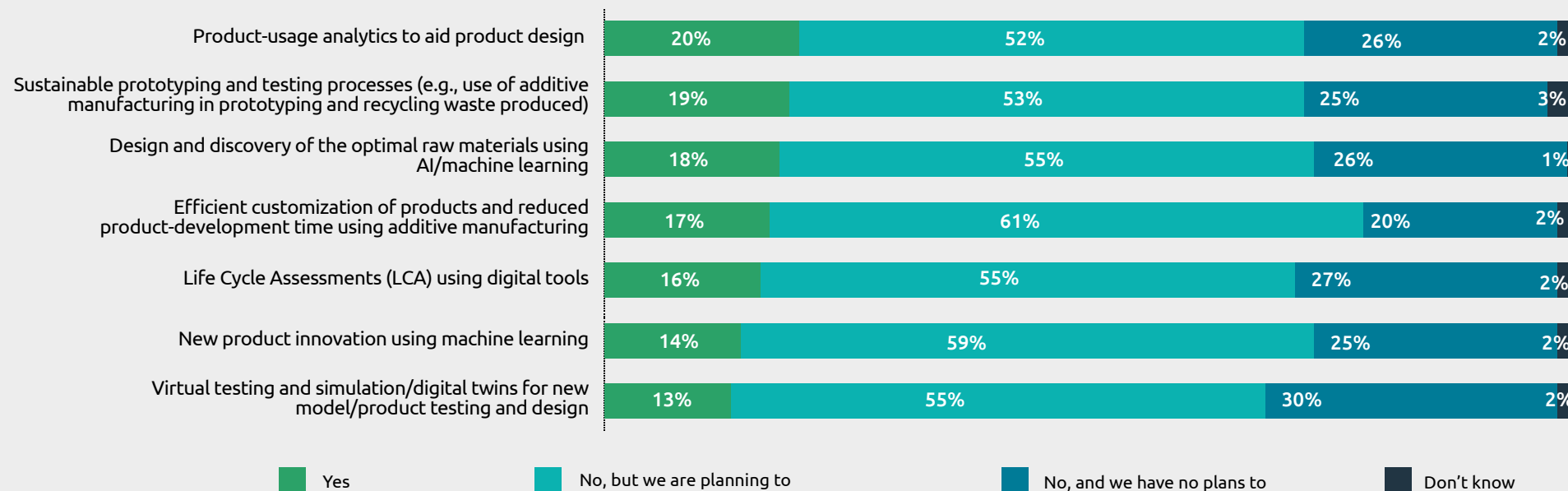
Organizations will need to utilize technology more efficiently and extensively to support their sustainable product design initiatives. They need to:

- Step up investments in research and innovation to identify new environmentally friendly materials and applications of technology to support sustainable product design. Denmark-based wind turbine manufacturer Vestas, for instance, has invested in Modvion – a Sweden-based technology company that specializes in making sustainable wind turbine towers using laminated veneer lumber (LVL) – a bio-composite material. Compared to conventional steel towers, the use of LVL reduces emissions by 80 percent from tower manufacturing operations due to the lower weight of the towers and the lower carbon dioxide intensity of the materials used.⁶⁶
- Ensure product design teams are working closely with data and digital experts so that they have access to the right data and tools.
- Account for emissions resulting from the use of technology – only 12 percent of organizations surveyed consider the carbon impact of digitization, while a further 66 percent say they are planning to in the future.

Fig.27

Organizations need to step up investment in technologies for sustainable product design

Is your organization using the following technologies to design products sustainably?

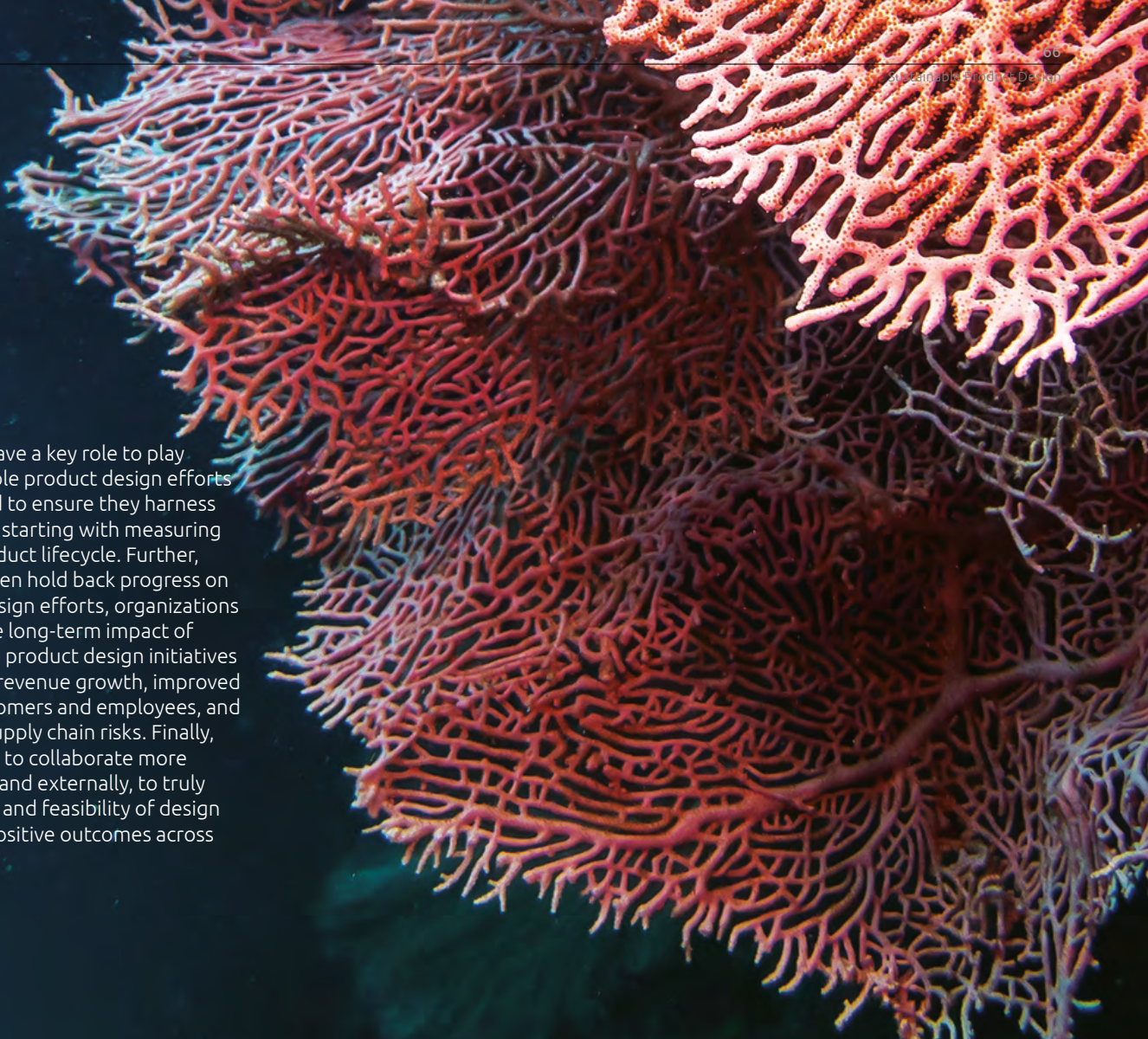


Source: Capgemini Research Institute, sustainable product design survey, April–May 2022, N=900 organizations.

CONCLUSION

As the IPCC's Sixth Assessment Report, launched in April 2022, shows, immediate and deep emissions reductions are required across sectors in order to limit global warming to 1.5°C.⁶⁷ To play their part in achieving these reductions and meeting sustainable development goals, organizations need to pay close attention to product design. Product design decisions have a profound impact on the environmental and social consequences of products. However, as our report illustrates, awareness of the environmental and social impacts of products is lacking, and few organizations are taking concrete action to design sustainable products. There is a critical need to accelerate. Organizations need to make sustainability a core strategic priority for product design teams and equip them to think systemically to avoid unintended consequences.

Data and technology have a key role to play in supporting sustainable product design efforts and organizations need to ensure they harness these tools effectively, starting with measuring impacts across the product lifecycle. Further, while cost concerns often hold back progress on sustainable product design efforts, organizations should bear in mind the long-term impact of investing in sustainable product design initiatives including cost savings, revenue growth, improved relationships with customers and employees, and reduced exposure to supply chain risks. Finally, organizations will need to collaborate more closely, both internally and externally, to truly understand the impact and feasibility of design decisions and ensure positive outcomes across the product lifecycle.

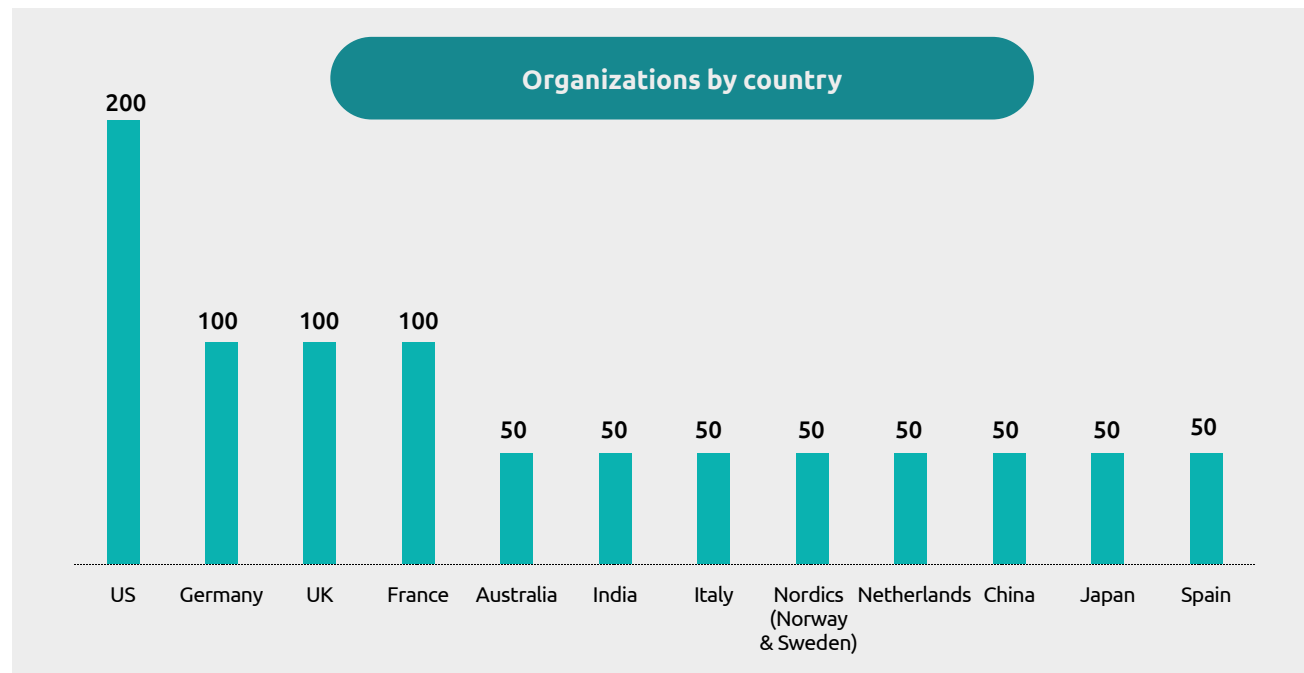


+ Research Methodology

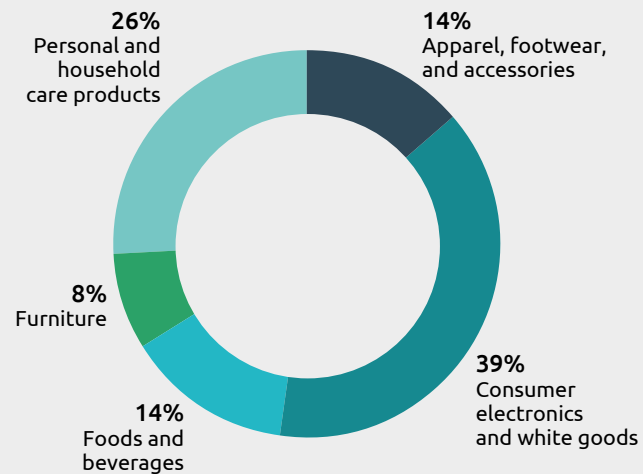
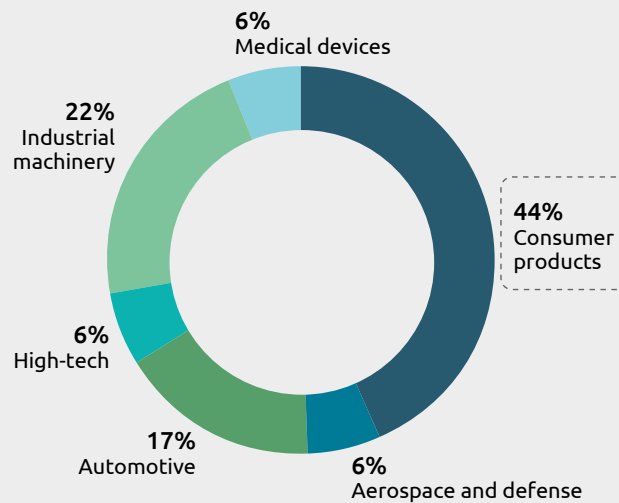
To understand whether organizations are embedding sustainability at the core of their design processes, we carried out extensive research with both quantitative and qualitative components.

Executive survey

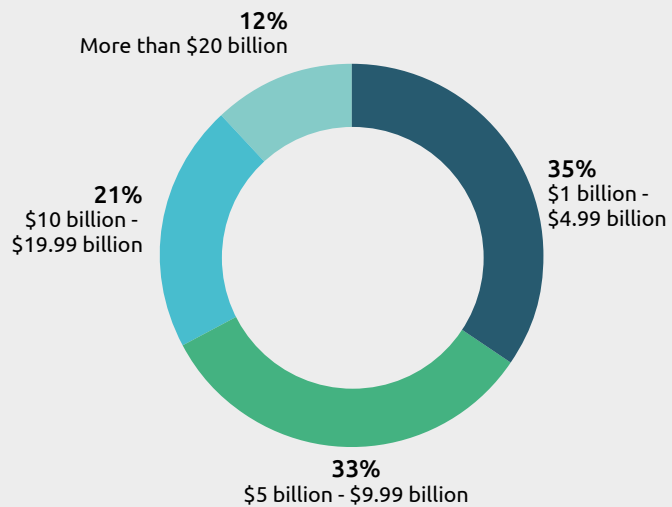
We surveyed 900 senior product design and engineering executives from large organizations across industries, including consumer products, automotive, industrial manufacturing, aerospace and defense, high-tech, and medical devices. The distribution of selected respondents and their organizations is provided below.



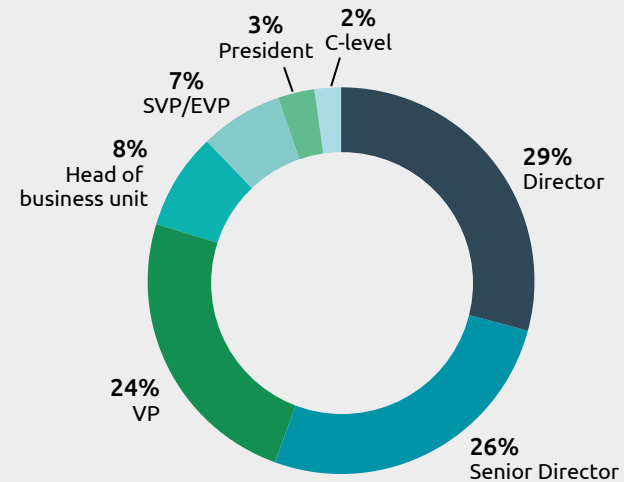
Organizations by sector

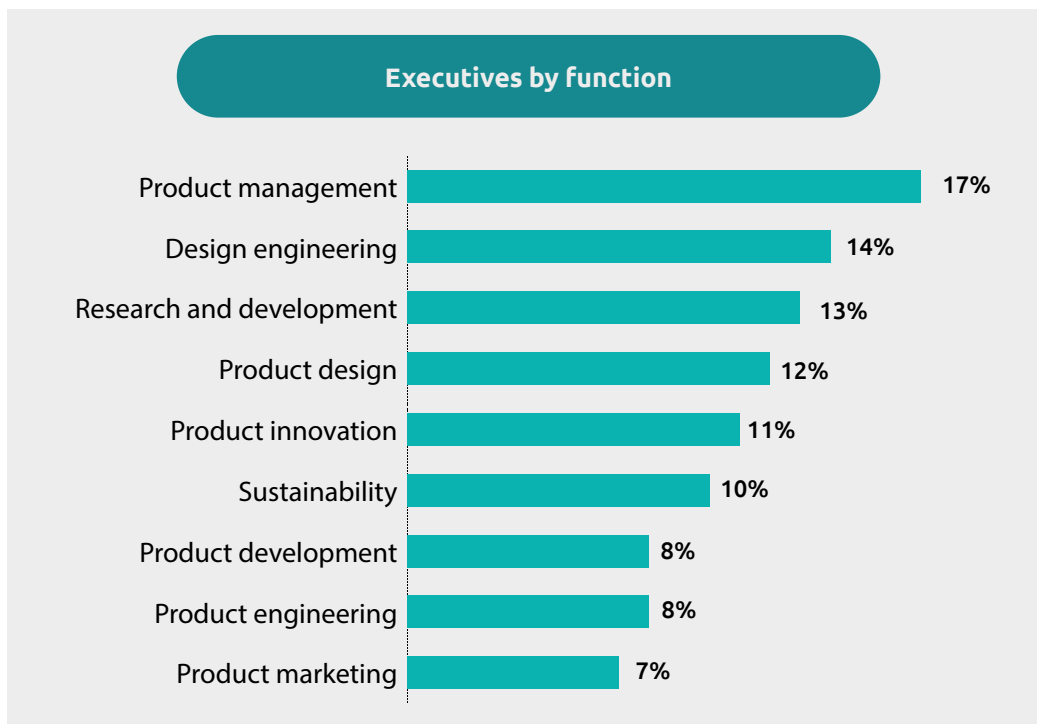


Organizations by annual revenue



Executives by title





In-depth interviews

We also conducted 15 in-depth interviews with senior industry executives and academics.

The study findings reflect the views of the people who responded to our online questionnaire for this research and are aimed at providing directional guidance. Please refer to the methodology for details of respondents and get in touch with a Capgemini expert to understand specific implications.

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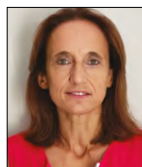
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The Capgemini Research Institute is Capgemini's in-house think tank on all things digital. The Institute publishes research on the impact of digital technologies on large traditional businesses. The team draws on the worldwide network of Capgemini experts and works closely with academic and technology partners. The Institute has dedicated research centers in India, Singapore, the United Kingdom, and the United States. It was recently ranked number one in the world for the quality of its research by independent analysts.

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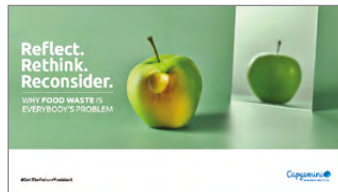
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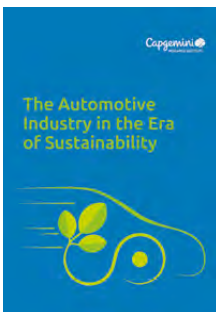
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