

## Review Article

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## Digital Transformation Balanced with Sustainability Goals

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### ABSTRACT

This research examines the relationship between digital transformation (DT) and sustainability, delving into the intricate dynamics and impacts of these concepts on technological advancements, environmental stewardship, and overall societal prosperity. It outlines the implications of DT on people, processes, and technology, along with global trends in DT adoption. The importance of integrating sustainability principles through digital transformation initiatives is highlighted, with a particular focus on the challenges faced by various industries. This study also discusses the measurement of sustainability, emphasizing the necessity of diverse environmental, social, and governance (ESG) metrics beyond CO2 emissions. Innovations such as Artificial Intelligence (AI) transformation are explored for their potential to enhance sustainability efforts. Success stories and positive trends in large organizations' sustainability journeys are shared, demonstrating the significant progress achieved thus far.

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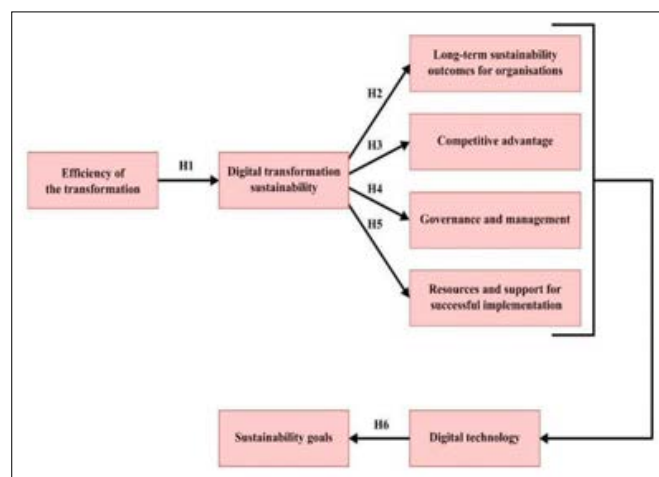
**Keywords:** Digital Transformation, Sustainability, Artificial Intelligence, ESG Metrics

### Introduction

Digital transformation represents a profound shift in how organizations operate, as it involves integrating digital technologies into all aspects of the business to fundamentally change how they function, deliver value to customers, and compete in the market [1]. This shift is significant because it requires organizations to continuously challenge the status quo, experiment, and embrace failure as part of the process of adapting to rapidly evolving technologies and customer demands.

Sustainability has emerged as a critical aspect of modern business practices because it shapes environmental, social, and economic outcomes. Organizations are increasingly recognizing the importance of incorporating sustainable practices into their operations to reduce their environmental impact, promote social responsibility, and ensure long-term financial viability. Sustainability is crucial for businesses to remain competitive, meet stakeholder expectations, and contribute to the overall well-being of the planet and society [1].

Balancing digital transformation with sustainability goals presents both opportunities and challenges for businesses. On one hand, digital technologies can enable more efficient and sustainable business practices, such as reducing paper usage, optimizing supply chains, and promoting remote work. On the other hand, the energy consumption and waste associated with digital technologies can have negative environmental impacts if not managed properly. Organizations must carefully consider how to leverage digital transformation to support their sustainability objectives while mitigating potential risks.



**Figure 1:** Implications of Digital Transformation

### Impact on People, Processes and Technology

Digital transformation (DT) influences organizational functioning and has a significant impact on people, processes, and technology. People's perceptions of work are altered by digital transformation (DT), which creates a culture of constant learning and flexibility, while simultaneously calling for new competencies. Employee proficiency with digital tools, data literacy, and cybersecurity awareness are requirements that must be met through continuous training and development initiatives.

Organizational processes are substantially reengineered to effectively harness digital technologies. More effective digital alternatives optimize, automate, and occasionally completely replace conventional workflow. Process simplification can result in a higher output, lower operating expenses, and better client experience. To guarantee smooth and coherent integration, strategic alignment of digital activities with business objectives is necessary.

From a technological perspective, DT drives the adoption of cutting-edge innovations such as artificial intelligence (AI), machine learning, cloud computing, and the Internet of Things (IoT). These technologies enable organizations to harness vast amounts of data, gain actionable insights, and make informed decisions. Additionally, cybersecurity has become paramount as digital ecosystems expand, necessitating robust measures to protect sensitive information and maintain trust.

### Global Trends in Digital Transformation Adoption

Globally, digital transformation is accelerating across industries, driven by the need to remain competitive and meet evolving customer expectations. According to a 2021 report by IDC, global spending on digital transformation is projected to reach \$2.3 trillion by 2023, indicating that organizations are making significant investments in this area [2]. Additionally, a survey by Gartner revealed that 87% of senior business leaders consider digital transformation to be a top priority for their organizations.

In the corporate landscape, many S&P 500 companies are actively pursuing digital transformation initiatives. For instance, a 2020 Deloitte study found that over 90% of these companies have embarked on some form of digital transformation, focusing on areas such as cloud computing, data analytics, and AI [3]. This widespread adoption underscores the critical role of digital transformation in maintaining market relevance and in driving business growth.

### The Defining Moment of AI Transformation

Artificial intelligence is poised to be a defining moment in the history of technology, heralding a new era of innovation and disruption. AI's transformative potential spans various domains, including healthcare, finance, manufacturing, and customer service. In healthcare, AI-driven diagnostics and personalized treatment plans are revolutionizing patient care. In finance, AI algorithms enhance risk assessment and fraud detection, whereas in manufacturing, AI-powered robots and predictive maintenance optimize production efficiency.

The adoption of AI is accelerating, with global AI spending expected to reach \$110 billion by 2024, according to IDC [4]. This surge in investment reflects the growing recognition of AI's capacity to drive significant economic and societal benefits. However, the integration of AI also raises ethical considerations such as ensuring transparency, accountability, and fairness in AI decision-making processes.

### Sustainability in the Digital Age

#### Sustainability in the Context of Digital Transformation

Sustainability in the digital age refers to the responsible development and utilization of digital technologies to achieve environmental, social, and economic goals. This emphasizes the need for organizations to integrate sustainable practices into their digital transformation efforts, ensuring that technological advancements do not compromise ecological integrity or social equity. This concept is often encapsulated in the term "digital sustainability," which focuses on the sustainable development and use of digital technologies, promoting practices that minimize the environmental impact while maximizing social benefits and economic viability.



**Figure 2: Digital Sustainability**

### The Growing Prominence of Sustainability

Sustainability has gained significant prominence in recent years owing to several interrelated factors.

**Environmental Awareness:** Increasing awareness of climate change and environmental degradation has prompted consumers, businesses, and governments to prioritize sustainability. The urgency of addressing these issues has led to the adoption of frameworks such as the United Nations Sustainable Development Goals (SDGs), which provide a global blueprint for achieving a sustainable future.

**Regulatory Requirements:** Globally, governments are implementing stricter regulations aimed at reducing carbon emissions and promoting sustainable practices. Organizations are compelled to adapt to these regulations to remain compliant and competitive.

**Consumer Expectations:** Modern consumers are more informed about the environmental and social impact of their purchases. This shift in consumer behavior has led businesses to adopt sustainable practices to meet customer expectations and enhance brand loyalty.

**Technological Advancements:** Digital technologies such as artificial intelligence, big data, and the Internet of Things offer innovative solutions to sustainability challenges. These technologies enable organizations to optimize resource use, reduce waste, and enhance transparency in their operations.

**Measuring Sustainability: A Complex Challenge** Measuring sustainability poses a considerable challenge owing to the intricate nature of assessing numerous environmental, social, and economic factors. Despite several established methodologies aimed at evaluating sustainability performance, determining the effectiveness of these approaches remains challenging.

One prominent framework is the Global Reporting Initiative (GRI), which offers extensive guidelines for transparency and consistency in sustainability reporting across diverse aspects,

such as environmental footprint, labor conditions, human rights, and corporate governance [5].

Another notable strategy is the Triple Bottom Line (TBL) approach, which examines organizational success through three lenses—people, planet, and profit—encouraging enterprises to strike a balance between fiscal health and societal and ecological responsibilities [5].

Life Cycle Assessment (LCA) considers a product or service's complete lifecycle, from resource procurement to discard, revealing potential improvements in sustainability [6]. To facilitate the comparison and assessment of sustainability endeavors within different entities, reporting systems such as GRI and the Sustainability Accounting Standards Board (SASB) establish uniformity in disclosure practices [4].

Environmental, Social, and Governance (ESG) criteria adopted by investors worldwide scrutinize company sustainability and ethical influence via several indicators, including carbon emissions, employee welfare, and executive diversity, thereby presenting a well-rounded image of an entity's sustainability performance [7]. Yet, despite these resources, accurately quantifying sustainability continues to elude many because of the convoluted interplay amongst varying elements and the demand for normalized evaluation parameters.

Therefore, developing efficient measurement instruments and frameworks becomes imperative for monitoring progress toward global sustainability objectives, as organizations incorporate sustainability principles into their digital transformation strategies. Ultimately, navigating sustainability in the digital era requires a delicate equilibrium between technological advances and environmental responsibility.

### Government and Big Tech Sustainability Goals

Governments and big tech companies are increasingly aligning their goals to address sustainability challenges, reflecting the growing recognition of the need for responsible environmental stewardship.

#### Government Initiatives

Globally, governments are implementing ambitious sustainability plans to combat climate change and encourage environmental care. The European Green Deal, introduced by the European Union (EU) in 2019, is one well-known example. Through a variety of initiatives, such as encouraging a circular economy, boosting renewable energy, and cutting greenhouse gas emissions by at least 55% by 2030 compared to 1990 levels, this comprehensive program seeks to make the EU climate-neutral by 2050 [8]. The Just Transition Mechanism is another component of the Green Deal that aims to ensure that the transition to a green economy is equitable and inclusive by supporting the industries and areas that will be most impacted.

The Biden administration in the US has re-entered the Paris Agreement and established a goal of reducing greenhouse gas emissions by 50–52% by 2030 compared to 2005 levels [9]. The administration's sustainability plan calls for making investments in electric cars, clean energy, and infrastructure upgrades that will increase resistance to the effects of climate change.

However, developing countries face significant challenges in meeting sustainability targets due to several factors. The heavy presence of energy-intensive factories is a major obstacle.

Industrialization, crucial for economic development, requires substantial energy consumption, often derived from fossil fuels. This industrial energy demand complicates efforts to reduce emissions. Additionally, growing populations in these countries result in greater energy demands for housing and urban infrastructure, further straining their capacity to adopt greener practices [10].

Climate change exacerbates these challenges. Rising temperatures and extreme weather events, such as heatwaves, floods, and storms, lead to higher energy consumption as people rely more on air conditioners, air purifiers, and heaters to maintain comfortable living conditions. This increased energy usage counteracts efforts to reduce overall consumption and emissions, creating a vicious cycle that hampers sustainability goals.

Addressing these issues is crucial for meeting global sustainability targets. Developing countries need support from developed nations through technology transfer, financial assistance, and capacity-building initiatives [10]. This collaborative approach can help bridge the gap between industrial growth and environmental responsibility. Investments in renewable energy sources, such as solar and wind power, can also provide sustainable alternatives to fossil fuels, reducing the carbon footprint of industrial and residential energy consumption.

Ensuring that all nations, regardless of their economic status, can achieve sustainability targets is vital for global efforts to combat climate change. The interconnected nature of our world means that the environmental actions of one country can have far-reaching impacts. Therefore, it is imperative to foster international cooperation and provide the necessary resources to support developing nations in their transition to sustainable practices [10]. Only through a unified and inclusive approach can we hope to meet the ambitious goals set forth in global sustainability initiatives like the Paris Agreement and the European Green Deal.

#### Big Tech Commitments:

**Amazon:** The company has pledged to achieve net-zero carbon emissions by 2040 through its Climate Pledge, which includes a commitment to power its operations with 100% renewable energy by 2025 [11]. Amazon has also invested heavily in renewable energy projects, securing over 20 gigawatts of clean energy globally.

**Apple:** Apple aims to make its entire product line carbon-neutral by 2030. The company has already reported avoiding 23 million metric tons of emissions and is focused on using recycled materials in its products [12].

**Google:** As part of its sustainability strategy, Google has committed to operating on 24/7 carbon-free energy by 2030. The company has also issued a \$5.75 billion Sustainability Bond to finance projects aimed at addressing environmental and social issues [12].

**Microsoft:** Microsoft has set a goal to be carbon negative by 2030, meaning that it plans to remove more carbon from the environment than it emits. The company is also investing in carbon removal technologies and sustainable practices across its operations [13].

#### Influence on Organizational Strategies

When it comes to implementing sustainability initiatives, many organizations look to the standards and frameworks established by governments and large corporations. Compliance with these guidelines not only satisfies regulatory requirements but also

enhances their reputation and marketability within the industry. Furthermore, investing in sustainable innovations and cleaner technologies allows them to abide by rules and cater to rising public demand for greener practices. An example would be the widespread adoption of cloud storage options designed with energy conservation and minimal carbon emission in mind.

Corporate Social Responsibility (CSR) plays a pivotal role in contemporary business strategy. Organizations realize that integrating sustainable methods fosters invention, improves efficiency, strengthens stakeholder ties, and ultimately leads to improved overall performance. Consumers play a vital role in driving this trend since they actively seek environmentally friendly products and services. Consequently, we witness a surge in green advertising and the creation of sustainable merchandise portfolios.

Finally, collaboration between businesses, authorities, and community partners contributes considerably to advancing sustainability targets. Such cooperation often results in pooled assets, skill-sharing, and amplified inventiveness regarding eco-friendly techniques. When organizations harmonize their activities with those championed by governments and major players, they strive to construct a more eco-conscious world while simultaneously solidifying their competitive positions.

### **Adaptation to Sustainability Goals**

#### **Integration of Sustainability Objectives and Metrics**

Firms are increasingly integrating sustainability objectives and metrics into their business processes to align themselves with global sustainability goals and enhance their competitive advantages. This integration often involves establishing clear sustainability targets, developing key performance indicators (KPIs), and embedding these metrics into strategic planning and operational frameworks. For instance, companies can adopt frameworks such as the Global Reporting Initiative (GRI) standards, which guide organizations in reporting their economic, environmental, and social impacts. By utilizing these standards, businesses can set meaningful KPIs that reflect their sustainability ambitions and effectively track progress. Tools such as SimaPro, a life cycle assessment software, facilitate the collection and analysis of sustainability data, helping organizations monitor their performance against established metrics and make informed decisions.

#### **Tools for Tracking Sustainability**

Organizations utilize both open-source and proprietary tools for tracking sustainability.

**Open-Source Tools:** Tools such as Open LCA provide free access to life cycle assessment software, enabling firms to evaluate the environmental impacts of their products and services without incurring high costs.

**Proprietary Tools:** Companies often invest in specialized software solutions, such as SimaPro and EcoStruxure, which offer comprehensive functionalities for data collection, performance monitoring, and reporting. These tools help organizations streamline their sustainability efforts and ensure compliance with regulatory requirements, while enhancing transparency and accountability.

#### **Microsoft Sustainability Cloud Offering**

**Microsoft Cloud for Sustainability** is a comprehensive suite designed to help organizations accelerate their sustainability progress while driving business growth. It integrates a range of environmental, social, and governance (ESG) capabilities

across the Microsoft cloud portfolio and solutions from a global ecosystem of partners.

#### **Carbon Emission Calculator**

**Emissions Impact Dashboard:** This tool allows organizations to estimate their carbon emissions and the emissions they have avoided by using Microsoft Azure and Microsoft 365 cloud services. It provides insights into the carbon impact of cloud workloads, helping organizations make informed decisions to enhance sustainability.

#### **Case Study: BAM and the Carbon Calculator**

**BAM UK & Ireland** utilized the Sustainability Tool's Carbon Calculator to improve supply chain transparency and engagement in decarbonization. By encouraging their suppliers to report emissions data consistently, BAM achieved greater transparency and improved engagement in their sustainability efforts. This case study highlights the importance of standardized carbon data collection and the positive impact it can have on an organization's sustainability goals [14].

#### **Other Hyperscalers' Offerings**

Other major cloud providers, known as hyperscalers, also offer sustainability tools to support various industries:

- **Google Cloud:** Provides tools for carbon footprint measurement and sustainability reporting, helping organizations track and reduce their environmental impact.
- **Amazon Web Services (AWS):** Offers sustainability solutions that include carbon footprint calculators and tools for optimizing energy usage in data centers.

These offerings from hyperscalers play a crucial role in supporting sustainability initiatives across different industries, helping organizations achieve their environmental goals.

### **Leading Industries and Challenges in Digital Transformation and Sustainability**

#### **Leading Industries in Sustainability Efforts**

##### **Technology Sector**

##### **Cisco Systems Inc**

Cisco has pledged to achieve net-zero emissions across all categories by 2040 and has made significant contributions to community programs [13]. However, the company faces challenges in reducing emissions from its supply chain and ensuring that all products and operations meet stringent environmental standards. Additionally, as a global company, Cisco must navigate varying regulations and sustainability expectations across different countries.

##### **Apple Inc**

Apple has successfully avoided 23 million metric tonnes of emissions across all scopes and is committed to using 100% recycled materials in its products [13]. Despite these efforts, Apple encounters challenges in sourcing sustainable materials, managing electronic waste, and maintaining transparency in its supply chain. The company also faces the task of balancing its rapid product innovation cycle with sustainable practices.

##### **Automotive Industry**

**Tesla:** Tesla is a leader in electric vehicles (EVs) and renewable energy solutions. The company's focus on sustainable energy has revolutionized the automotive industry [15]. Nevertheless, Tesla grapples with challenges such as the environmental impact of lithium-ion battery production, the need for widespread EV charging infrastructure, and the sustainability of its supply chain, particularly concerning the ethical sourcing of raw materials.

**Toyota:** Toyota has been at the forefront with its hybrid technology and is investing heavily in hydrogen fuel cell technology [15]. The company faces challenges in scaling up hydrogen fuel infrastructure, reducing the carbon footprint of its manufacturing processes, and transitioning from hybrid to fully electric vehicles in response to increasing regulatory pressures and market demands for zero-emission vehicles.

#### **Consumer Goods**

**Unilever:** Unilever has promised to make all of its plastic packaging reusable, recyclable, or biodegradable by 2025. Despite this commitment, Unilever faces challenges in finding sustainable packaging alternatives, ensuring global consistency in packaging policies, and managing the cost implications of transitioning to greener packaging. Additionally, achieving consumer behavior change towards recycling and reusability remains a significant hurdle.

**Procter & Gamble:** P&G aims to achieve net-zero greenhouse gas emissions across its operations and supply chain by 2040 [13]. The company encounters challenges in reducing emissions across a vast and complex supply chain, developing sustainable product formulations, and maintaining cost-effectiveness while implementing green technologies. Ensuring supplier compliance with sustainability standards and addressing consumer expectations for sustainable products also pose ongoing challenges.

#### **Challenges Faced by Other Industries**

Heavy manufacturing industries, such as steel production face significant challenges in reducing their high-energy consumption and carbon emissions. The process of making steel is extremely energy intensive, which makes it difficult for these companies to reduce their environmental impact. Similarly, the agricultural sector faces the challenge of reconciling the need to boost food production with the adoption of sustainable practices. Farmers are under pressure to find ways to reduce methane emissions from livestock and manage water resources more efficiently while meeting the world's growing demand for food.

The fashion industry is also facing its own set of sustainability issues. With fast fashion brands churning out cheap and trendy clothes at an alarming rate, a large amount of waste is generated. Additionally, the industry uses massive amounts of water to produce garments, placing even more strain on this precious resource. While some brands are beginning to embrace sustainable practices, many are moving too slowly, held back by the industry's reliance on quick production cycles and low-cost materials [15].

Finally, the energy sector is facing the greatest challenge of transitioning away from fossil fuel and embracing renewable energy sources. This is not an easy feat, as traditional oil and gas companies have built their entire business around non-renewable resources. Shifting gears toward cleaner alternatives will require major changes not only in their operations but also in their overall business models. Despite these challenges, many experts believe that the move toward renewables is both necessary and inevitable if we hope to address the climate crisis and create a more sustainable future.

#### **Measuring Sustainability Beyond CO2 Emissions Importance of Diverse Metrics**

Although CO2 emissions are a critical metric for assessing environmental impacts, they are not the sole indicators of sustainability. Organizations must adopt a holistic approach to sustainability measurement that encompasses various environmental, social, and governance (ESG) factors. This broader perspective includes tracking water usage, waste reduction, energy consumption, and biodiversity impacts, which are essential for understanding a company's overall sustainability performance [16].

#### **Additional Sustainability Metrics**

When it comes to sustainability metrics, there are several key areas that organizations focus on to minimize their environmental impact and maximize their social responsibility. One such metric is water usage, which involves monitoring the amount of water consumed by a company to manage resources more effectively and reduce costs [17]. This is especially important in industries such as agriculture and manufacturing, where large quantities of water are often required for production processes. By prioritizing water efficiency, these industries can help mitigate the risks associated with water scarcity and ensure long-term sustainability.

Another critical area of focus is waste reduction, which involves tracking the amount of waste generated by a company and implementing waste management strategies aimed at minimizing environmental harm. Many organizations are now embracing the principles of the circular economy, which emphasizes recycling and repurposing materials rather than simply sending them to landfills. Through these efforts, companies can significantly reduce their contribution to landfill waste and contribute to a more sustainable future.

One of the most well-known sustainability metrics is energy efficiency, which involves measuring a company's energy consumption and transitioning to renewable energy sources wherever possible. By adopting energy-efficient technologies and practices, organizations can lower their carbon footprint and demonstrate their commitment to environmental stewardship.

Finally, a newer area of focus in sustainability metrics is biodiversity impact, or the assessment of a company's effect on local ecosystems and wildlife populations [17]. As many experts recognize the importance of preserving biodiversity for the health of our planet, organizations are starting to take steps to understand and mitigate their impacts on local ecosystems. By doing so, they can help ensure that their operations remain sustainable over the long term, while contributing to the broader goal of protecting our natural environment.

#### **Hyperscalers' Approach to Sustainability Comparison of Azure, AWS, and GCP**

The leading cloud service providers—Microsoft Azure, Amazon Web Services (AWS), and Google Cloud Platform (GCP)—have made significant commitments to sustainability [18]. The following is a comparison of their sustainability practices:



**Table 1: Comparison of Sustainability Practices by leading Hyperscalers**

Feature/ Provider	Microsoft	Amazon	Google
Renewable Energy Commitment	100% renewable energy by 2025	100% renewable energy by 2025	100% renewable energy by 2030
Carbon Neutrality	Carbon negative by 2030	Net-zero carbon by 2040	Carbon-free energy by 2030
Water Usage	Water positive by 2030	Water stewardship initiatives	Water stewardship initiatives
Energy Efficiency	Advanced cooling technologies	Custom energy-efficient hardware	Machine learning for energy efficiency

**Benefits for Customers**

Customers who utilize services from hyperscaler platforms such as Azure, AWS, and GCP experience several key benefits. One of the primary advantages of this method is cost savings. Efficient resource management and the use of renewable energy by these providers can reduce the operational costs. Additionally, by adopting sustainable practices, organizations can meet regulatory requirements, ensure compliance, and avoid potential fines. Partnering with environmentally responsible providers also enhances a company's brand reputation, showcasing its commitment to sustainability and appealing to environmentally conscious consumers. Moreover, customers gain access to cutting-edge technologies that drive innovation and improve overall sustainability [19].

**Collaboration for Sustainable Transformation**

Collaboration among industry leaders is essential for driving sustainable transformation. Organizations can accelerate their sustainability efforts and achieve greater impacts by sharing best practices, technologies, and resources. Collaborative initiatives can lead to the development of standardized metrics and frameworks that facilitate transparency and accountability across industries [20].

Reports from organizations such as Gartner and Forrester emphasize the importance of collaboration in achieving sustainability goals. For example, Gartner highlights that companies engaging in collaborative sustainability efforts often see enhanced innovation and improved stakeholder engagement [21]. Similarly, Forrester underscores that partnerships can lead to shared resources and knowledge, enabling faster progress toward sustainability targets [20].

**Conclusion**

In conclusion, the integration of digital transformation and sustainability is a critical requirement for organizations aiming to balance environmental stewardship, social responsibility, and economic growth. The transformation brought about by digital technologies significantly affects people, processes, and technology, requiring organizations to adapt and evolve. With global trends showing increasing investments in digital transformation, it is essential to embed sustainability principles throughout these initiatives [22-25].

The rise of Artificial Intelligence (AI) and other advanced technologies offers opportunities for organizations to enhance

their sustainability efforts. By leveraging AI's capability to analyze vast datasets, organizations can better measure and monitor their environmental impact, identify inefficiencies, and develop targeted strategies for improvement. Technologies such as IoT, cloud computing, and big data also contribute to reduced energy consumption, optimization of resources, and the promotion of circular economies.

Large organizations have demonstrated successful examples of integrating sustainability into their digital transformation journeys. By setting ambitious carbon reduction targets, committing to renewable energy, and focusing on socio-environmental responsibility, these organizations serve as inspiration for others to follow suit. Moreover, collaborative efforts among industry leaders, technology providers, and government agencies can further accelerate sustainable transformation by sharing best practices, resources, and knowledge.

In essence, technology acts as a catalyst for organizations to track, meet, and exceed their sustainability goals. By harnessing the power of digital transformation and sustainability in tandem, businesses can drive innovation, enhance brand reputation, ensure long-term competitiveness, and contribute positively to the well-being of our planet and society.

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