ISBN: 978-93-6773-804-7

CHAPTER 5

SUSTAINABILITY AND TECHNOLOGY: MERGING ENVIRONMENTAL GOALS WITH BUSINESS STRATEGIES

RASHMI SACHAN
ASSISTANT PROFESSOR, DEPARTMENT OF COMMERCE,
LUCKNOW PUBLIC COLLEGE OF PROFESSIONAL STUDIES, LUCKNOW, U.P., INDIA
MAIL ID: sachanrashmilpcps@gmail.com

KEYWORDS

GREEN TECHNOLOGIES, ENVIRONMENTAL, SUSTAINABILITY, BUSINESS STRATEGY, GREEN TECHNOLOGY, ENVIRONMENTAL IMPACT, RENEWABLE ENERGY, AUTOMATION, CARBON FOOTPRINT, TECHNOLOGIES, CSR, FUTURE TRENDS.

ABSTRACT

It has forced the change of strategy of businesses as they have been challenged by the environmental issues. "Sustainability and Technology: Combining Environmental Aspirations with Commercial Strategies" is the book on the changing relationship between technology and sustainability as it applies to business. In this chapter, we will learn about how organizations are using emerging technologies (renewable energy, automation, green manufacturing) to incorporate environmental objectives into corporate initiatives. It talks about how green technologies can help reduce carbon footprint, how to incorporate sustainability in business models, and how to make sustainable technology adoption. The chapter also covers trends and future sustainability innovations that are changing the corporate landscape. Bringing to light the convergence of technology and sustainability, companies can reduce their environmental footprint as well as create sustainable growth and profit.

5.1 INTRODUCTION TO SUSTAINABILITY IN BUSINESS

Sustainability has become a cornerstone of companies all over the world not only ethically, but also in order to succeed in the long term. Sustainability is not an outlier

in the new business world; it is at the heart of the way companies work and choose. Sustainability does not stop with the environmentalism and is also social and economic that plays a role in a business' resilience, growth and credibility. And companies have to deliver to their stakeholders – customers, shareholders, regulators, and society as a whole – who increasingly expect them to be sustainable, least harmful to the environment and most socially impactful.

5.1.1 WHAT IS SUSTAINABILITY AND WHY DOES IT MATTER IN THE TODAY'S BUSINESS WORLD?

Sustainability business is defined as practice that is equal parts economic development, environmental sustainability, and social responsibility. It's about bringing shareholder and society value by making environmental, social and governance (ESG) considerations part of corporate processes. The economic, environmental and social pillars of sustainability do not go together. Sustainable companies want to make money, leave as little carbon footprint as possible and build good relationships with their employees, clients and society.

The environmental side of sustainability is all about a lesser use of resources, less waste and less degradation. Green-enabled businesses — with their use of renewable energy, low-energy production and sustainable sourcing — not only reduce the environmental impact, they're also in the driving seat for responsible corporate citizenship. The social side values fair labour, community engagement and supply chain management to make sure that companies support society. Third is the financial side — sustainable will make you money — when you combine the two, you get long-term financial returns, risk reduction, and more brand loyalty.

Sustainability is essential in today's business world for many reasons. First, with growing concerns about climate change, environmental destruction and social inequality, consumers and investors have demanded more sustainable behaviors from companies they invest in. The pressure on businesses is also fueled by international frameworks such as the United Nations Sustainable Development Goals (SDGs), which are a guide for companies to connect their approach with global issues. What's more, environmental regulations are being imposed by the government and require companies to make more sustainable decisions or else face penalties and public image damage. More frequent climate disasters also signal to us that sustainability is not only a trend, it's a survival requirement for companies.

5.1.2 THE EVER-EVOLVING NEED FOR BUSINESSES TO ADAPT ENVIRONMENTAL PURPOSES TO MAKING PROFITS.

This increased demand for companies to combine the environment with profit-based business models has multiple and overlapping causes: regulation, consumer demand, and an appreciation that sustainability can open up new markets. As always, the image of sustainability was that it went against profitability – that it was a cost-sensitive movement. But this is no longer the case, because companies have learned that sustainability can help them improve their processes, penetrate new markets, and boost profits. Sustainable is one of the reasons why businesses have more and more aligned sustainability with profit targets because of its competitive advantages. Green technologies, energy savings and reduced waste save businesses money in the long run. - Energy-saving production can save on energy, for instance, and landfill costs can be reduced through waste reduction efforts. Additionally, resilient supply chains could be less vulnerable to disruption and better maintained for the long run. In taking sustainability into account, enterprises save not only the environment but also operationally improve their bottom lines.

Other big drivers for the balancing of environmental ambitions with profit are consumers' preferences. The consumer today is more informed than ever about the environmental and social impact of the products he buys. And more people are choosing brands based on their values, especially those focused on sustainability. Research shows that the consumer will pay more for eco- or socially sustainable goods and services. The consumer trend makes companies an ideal platform to enter a new market segment that is increasing its needs for sustainable goods. Organizations that miss these trends are in danger of losing customers and market shares to competitors with higher values at the consumer level. Moreover, sustainability is becoming more of a innovation engine. Green technologies and sustainability are always followed by new products, services, and businesses. Businesses, for example, who follow circular economy values — where goods are reusable, recyclable or repurposed — create new revenues. So too do companies that invest in renewable energy or carbon neutral technologies not only reducing their environmental footprint, but becoming pioneers in a new market. These are the kinds of innovations that investors are typically approving of because they're starting to factor in environmental, social and governance (ESG) considerations. As ESG investing becomes more mainstream, organizations with sustainability as part of their operations will attract capital and see growth over the long term.

Companies are under more and more pressure to be in line with the environment laws and policies. Governments all over the world have introduced new environmental policies such as carbon taxes, emission caps and sustainability reporting. Businesses that lead by example with sustainability are best able to deal with these regulations and be exempt. Also, linking environment with business initiatives can help get businesses in front of the policymaking table to demand industry standards. Investing in sustainability helps companies cultivate stronger relationships with governments, regulators, and industry groups.

5.2 TECHNOLOGICAL INNOVATIONS DRIVING SUSTAINABLE PRACTICES

Technologies have been an engine for driving sustainability in industry over the past few years. While organizations are increasingly taking environmental responsibility seriously, they're looking to cutting-edge technologies to mitigate their impact on the environment, use more efficiently and develop greener business models. Renewable energy, smart manufacturing, waste management, automation and the Internet of Things (IoT) are among the technologies leading this change. These are innovations that help businesses not only meet sustainability objectives but also opens up new opportunities for growth, efficiency and environmental conservation.

5.2.1 THE MOST IMPORTANT TECHNOLOGIES UNDERWRITING ECOLOGICAL BUSINESS MODELS

- **Renewable Energy Technologies:** Among the most important technological advances in sustainability is the creation and mass production of renewable energy. Old fossil fuels – coal, oil, gas – have been at the foundation of industrial manufacturing and energy use for generations. Yet they've also been the largest emitters of greenhouse gases and climate change. Renewable energy sources like solar, wind, geothermal and hydropower are a clean, renewable solution. Solar and wind energy specifically have seen major improvements in recent years, as costs are decreasing, the efficiency increases and more systems are being deployed. The corporations are already investing in solar panels, wind turbines and other clean power to run their operations. This transition not only cuts their carbon footprint but also decreases their reliance on fossil fuels to be energy independent. We see, for instance, that companies such as Tesla and Google are already committed to 100% renewable energy — showing the power of mega-corporations to be the innovators in renewable energy. Not only are renewable

energy sources cleaner, but they generate economic value. Companies who invest in renewable energy can save energy costs over the long term as the price of power from a solar array or wind turbine keeps falling. Moreover, companies that are embracing renewable energy technologies also tend to be liked by environmentally aware customers which helps in building brand recognition and loyalty.

- **Smart Manufacturing Technologies:** Smart manufacturing is another technology propelling sustainable business models. It is a term used to describe the use of digital technologies (AI), robotics, data analytics etc into manufacturing processes to improve productivity, eliminate waste and use less energy. It is a product of Industry 4.0, which aims to make manufacturing sustainable and more agile according to market needs. With sensors, AI and machine learning algorithms, smart factories are able to keep an eye on production in real time, spot waste, and streamline operations. These systems can save raw materials, energy and water by automating the process, reducing downtime and identifying maintenance needs before machines fail. AI-based predictive maintenance can, for instance, spot defects in machinery before they cause breakdowns, reducing the need for repair, waste of energy and production delays.

  Furthermore, smart manufacturing technologies can also be applied to the movement towards a circular economy, in which products are made for reuse, recycling or remanufacturing. Embracing the concept of sustainable design along with data analytics allows companies to make products that use less resources and don't get thrown away. For instance, in electronics, manufacturers are using smart manufacturing to create less complicated, dismantled and recycled products that last longer and produce less waste electronics.
- **Waste Management Systems:** Technology in waste collection is now essential for businesses that want to make a difference. Ineffective waste disposals allow businesses not only to create as little waste as possible, but also to recycle and reuse material to reduce their reliance on raw materials. Advanced technologies like automated sorting, composting and waste-to-energy technologies help companies handle their waste streams in an eco-friendly manner. Automation and robotics are being implemented for a better waste sorting and recycling process. Companies are, for instance, investing in AI-driven sorting that automatically divides recyclables from non-recyclables to minimize the human bias and improve the accuracy of recycling. Moreover, waste-to-energy

technology like anaerobic digestion and incineration are being employed to turn organic waste into biogas which is then utilized as a renewable fuel.
Businesses gain from adopting waste technologies, which are environmentally friendly and entail business. The more that they can minimize waste and recycling the cheaper they can dispose of it and take away the environmental responsibility. Companies can sometimes also sell recycled material or repurposed goods and make some extra cash.

5.3 AUTOMATION AND IOT: USING IOT TO REDUCE THE ENERGY USE AND NEGATIVE ENVIRONMENTAL IMPACT

Automation is changing industries, by making manufacturing processes more efficient, less requiring human intervention, and making the most of available resources. Businesses can perform simple operations through robotics, AI and machine learning algorithms that optimize production process. Automation saves energy, waste and increases productivity. For instance, in agriculture, automation with drones and automated irrigation are being applied to water savings, crop safety and chemical reductions. Automatic irrigation system that can use sensors and data analysis to deliver exactly the right amount of water to the crops to save water and ensure they are getting exactly what they need. The technology saves water, as well as energy and yields crops.

So, too, in manufacturing, automation (robotics, etc.) systems are used to restructure processes and reduce consumption of resources. The repetitive work can be done by robots, more precisely and faster than by humans, and thus less energy intensive and wasteful. Automation reduces the carbon footprint of manufacturing processes and increases overall efficiencies by regulating production schedules and minimising time spent in standby mode.

5.4 IOT FOR MONITORING AND OPTIMIZATION: INTERNET OF THINGS (IOT) FOR MONITORING AND OPTIMIZATION

Another essential technology is the Internet of Things (IoT) that can help businesses to keep track of their use of resources. IoT: Is a network of interconnected devices, that can share data and communicate in real-time. Sustainable: IoT appliances monitor and control energy, water, waste, and other environmental data.
Buildings could be monitored with IoT sensors, for example, to track energy usage and control heating, cooling and lighting based on occupancy and weather. This real-

time information helps enterprises to avoid energy wasting by only operating when they need it. IoT devices, too, are being deployed in factories to inspect machine performance and identify inefficiencies. IoT-based predictive maintenance can keep businesses informed of a breakdown before it costs them money or the environment. On the agricultural side, IoT tools are being applied to track soil moisture, weather and productivity of crops. Such data-driven solution allows farmers to schedule irrigation more efficiently, save water and waste less pesticides and fertiliser, which makes farming more sustainable.

5.5 INTEGRATING SUSTAINABILITY INTO BUSINESS STRATEGY

In this rapidly changing business climate, sustainability as part of the business plan is no longer a luxury – it's a necessity. As consumers' awareness, regulatory oversight and environmental degradation increases, corporations will need to balance their business practices with ESG objectives. It's a term now applied to sustainability, which means achieving long-term growth, operational effectiveness, and risk reduction while doing good for society and the Earth. Sustainability as a strategic enterprise is an integration of sustainable practice across every department in a company's business, from supply chain to product development, and aligned with company objectives and values. It takes intentional behaviour, creativity, and mental shift on all levels of the organization.

5.5.1 WAYS TO INCORPORATE ENVIRONMENTAL SUSTAINABILITY INTO BUSINESS GOALS AND STRATEGIES

- **Top-Down Commitment and Leadership:** The first thing required for sustainability as a part of business strategy is the sustainability commitment of senior leadership. It all starts with effective leadership that has environmental objectives and communicates them to everyone in the organization. Not only in policy or statement but in resource management, business decision making, corporate culture. For example, sustainability should be a focus of leaders' mission and vision statements for the business, with tangible targets to mitigate carbon emissions, waste and resource use.

  Top-down commitment also means that sustainability is built into the way the company operates. It is the leadership who needs to champion sustainable habits and organise the organizational change required. Directors of firms such as Unilever or Patagonia, for instance, have made sustainability a core part of their

brand, setting high-level environmental and social targets, and funding them through resources, investments and innovation. It's a leadership pledge that not only lays the foundation for long-term business, but models it to employees, partners, and customers.

- **Defining Specific and Realistic Sustainability Objectives:** Part of encoding sustainability is the creation of clearly defined, quantifiable, and realistic sustainability targets. These should be connected to the wider business purpose and the primary environmental implications. So, for example, a company could have energy efficiency targets, or a single-use plastics ban, or carbon neutrality by the year. They should be goals that can be monitored and monitored with key performance indicators (KPI) in order to keep a check on how things are progressing and tweaking accordingly.

  Incorporate sustainability objectives into business goals – companies will not look at environmental initiatives in isolation, but as core business strategies. These objectives too must be periodically revisited to make sure they are up to date when new challenges or opportunities present themselves. A company, for instance, might decide to achieve a 20% reduction in water consumption in its production process in five years, which it could achieve through water management and energy-saving technologies.
- **Sustainable Supply Chain Management:** Green supply chain management is important in making sustainability work for your business. Businesses do not always have control over the environmental behaviour of their suppliers, who can contribute to an extremely high proportion of their total carbon footprint. Thus, companies need to work with their suppliers to enhance their environmental management, so sustainability can run through the supply chain.

  In order to embed sustainability into the supply chain, companies can implement such things as sustainable raw material source, suppliers using a labour ethic, and products designed to be recyclable or reused. Companies can also demand that suppliers have environmental certificates or standards like ISO 14001 (environmental management systems) or Fair Trade. This not only reduces the environmental footprint but also adds transparency and reduces the risks associated with unethical or non-sustainable practices in the supply chain. Brands such as IKEA and Nike have been very successful in working with suppliers that are sustainability compliant, which means taking the environment into account when doing business.

- **Sustainable Product Design and Innovation:** Making sustainability a business strategy is making products and services that consumers want and which leave the least footprint. The sustainable product design involves environmentally sound materials, less waste production and products with long life cycles or can be recycled at the end of use. They are meant to eliminate the negative environmental footprint of products and services at all stages of their lifecycle: raw material extraction to production, consumption and recycling.

  Companies also have the option to spend on research and development (R&D) to build green and profitable solutions. The Teslas and BMWs, for instance, were first to produce electric vehicles (EVs), decreasing carbon emissions and fossil fuel consumption while responding to the ever-increasing consumer need for greener transportation. And businesses can develop products for the circular economy, in which goods are made to be reused, remade or recycled, to make the economy more sustainable and resource-efficient.
- **Employee Engagement and Training:** Companies' employees are instrumental to sustainable organizations. Implementing sustainability into the business operations means not only bottom-up decision-making but sustainability culture at every organizational level. It is done through employee engagement, training and giving employees the chance to give feedback and participate in sustainability programs.

  Companies can also offer sustainability training courses, for instance, so employees understand the environmental impact of their jobs and how they can support sustainable practices. By inviting employees to participate in sustainability activities (e.g., less office energy use, more recycling, environmental activities), employees feel ownership and responsibility. The more that employees can take the lead in sustainability initiatives, the more innovative and responsible it will be to the business's long-term sustainability strategy.

5.5.2 INTEGRATING CORPORATE VALUES, OBJECTIVES AND SUSTAINABLE MODELS TO CREATE LONG-TERM SCALE

- **Creating Shared Value:** To be able to achieve long-term growth it's critical that the company values align with sustainability work. Shared value is the act of generating economic value while generating value for society by solving its needs and problems. Corporate leaders that embrace sustainability are creating

not just greener and better for the planet, but new revenue opportunities, a better reputation and deeper ties with customers and communities. Starbucks for instance has moved towards the shared value model with their sustainability agendas (fair trade of coffee beans, sustainability, and community involvement). By keeping sustainability on-brand, Starbucks is building a market share while at the same time doing great for the society. Shared value-oriented businesses are considered more reliable, and so customers become more loyal and promoters of brands.

- **Long-Term Strategic Vision:** Incorporating sustainability into corporate agendas requires strategic long-term thinking. It is no longer merely short-term profitability to pursue – sustainability must become part of the future success of the firm. A sustainable vision is a strategy that isn't an immediate return but one that, in the long run, will benefit brand equity, risk mitigation, and bottom line. For example, if businesses now start investing in green or renewable energy, the cost of this upfront investment could be more expensive in the long term as energy costs and compliance expenses go down. When companies go sustainable, they are limiting the risks to the environment while positioning themselves for the future. Integrating business objectives with sustainable objectives makes the company resilient against environmental changes and market forces.
- **Transparency and Accountability:** Reporting sustainability performance has to be transparent for business operations to meet corporate values. Companies that make it clear what they are doing to address their environmental, social and governance (ESG) is trustworthy with customers, investors and others. It is possible to do this with the aid of sustainability reports, which report on key performance indicators, sustainability measures, and future outlook for the company. Businesses that are transparent and accountable to themselves for their environmental policies have the advantage of appealing to environmentally minded customers and investors, and can be sustainable. Even companies such as Patagonia that openly disclose sustainability practices and targets have gained customer trust and loyalty through their authentic environmental responsibility.

5.6 THE ROLE OF GREEN TECHNOLOGIES IN REDUCING CARBON FOOTPRINT

In this era when climate change is becoming an issue for every business, green technologies are a way for companies to conserve nature and reduce their carbon emissions. Incorporating green technologies, including solar power, electric vehicles

(EVs), carbon capture and storage (CCS), and energy-saving solutions, helps companies get in the right direction. Not only are these technologies a part of how companies must stay compliant with ever more stringent environmental legislation, they also afford opportunities for cost reduction, operational efficiency, and branding. Green technology is changing industries and propelling a low-carbon economy across the world.

5.7 USING GREEN TECHNOLOGIES TO MAKE THE ENVIRONMENT ECO-FRIENDLIER

5.7.1 SOLAR ENERGY AND CLEAN ENERGY SOLUTIONS

The best green technology today is solar energy, allowing organizations to shift from fossil fuels to renewable energy sources. Solar power can also replace grid electricity that is not renewable, thus reducing carbon emissions. Organizations can use photovoltaic (PV) panels on the roof, solar farm or any other vacant space to create their own electricity, save on electricity bills, and help towards a more sustainable future. And solar power is particularly helpful for companies with a carbon footprint because it's a huge reducer of greenhouse gas emissions. In the example of big businesses, Google, Apple and Microsoft have all pledged to source 100% of their energy from renewables with the help of solar power. By using solar, companies will be less fossil fuel dependent, less costly to run and with better environmental credentials. Small companies can also join community solar farms or buy RECs to offset carbon. Solar power systems can be bundled with other green technologies for even more eco-friendly output. With a combination of battery storage, for instance, companies can store excess daytime solar power for the night or when demand is high. The integration increases energy security and grid dependence, thus decreasing carbon emissions.

5.7.2 ELECTRIC VEHICLES (EVS)

Transport is one of the largest carbon producers on the planet and traditional ICE cars rank as one of the most polluting vehicles. Electric Vehicles (EVs) can also be a promising source of emission reduction, cleaner than gas- and diesel engines. Because EVs run on electricity, often from renewable sources, and have zero tailpipe emissions, they're a vital part of any organization's green tech programme. If you are a business that depends on vehicles to be able to transport cargo, deliver products, or even drive employees around town, switching to EVs can have a major impact on your carbon footprint. Companies like Amazon, FedEx and DHL are making the

switch to electric delivery trucks that reduce their carbon footprint and their dependence on fossil fuels. Not only are EVs no tailpipe emissions, but they also cost less to run than traditional cars due to lower fuel costs and maintenance. That makes businesses save money while meeting their sustainability goals.

In addition, the rollout of EV infrastructure (charging stations, etc.) has further made the transition to electric mobility rapid. Companies can continue to act sustainable through the investment in EV fleets and charging stations that can avail of tax breaks and government incentives. EVs will only get more efficient and less expensive in the future as batteries continue to advance and more companies and consumers will start to adopt them.

5.7.3 CARBON CAPTURE AND STORAGE (CCS)

Another emerging green technology is carbon capture and storage (CCS) that can reduce CO2 emissions especially from high CO2-bearing sectors such as cement, steel, and chemical industry. CCS systems capture carbon dioxide emissions in the production facility — power plant, factory, etc. — before they escape into the atmosphere. The sucked-up CO2 is then taken off and buried deep underground in rocks or used for other purposes (for example, to increase oil recoveries or create chemicals). CCS holds out promise in industries that remain very difficult to decarbonise like heavy industry and cement. For instance, Shell, BP and Equinor are some of the most progressive companies that are investing in CCS technologies as part of their sustainability plan. The trapped CO2 can be held indefinitely, so it cannot warm the world. Moreover, CCS could be combined with renewable energy sources like solar or wind to make "net-zero" or "negative emissions" plants that scavenge carbon from the air. CCS is not yet widely applied, but it could be an important tool in combating climate change. With the technology evolving, it is set to become a key enabler of businesses' carbon neutrality objectives. CCS investment will be further encouraged through government incentives and regulations – and will be a key part of corporate sustainability plans in the future.

5.7.4 ENERGY EFFICIENCY AND SMART TECHNOLOGIES

Energy efficiency is an important part of carbon reduction and sustainability in business. Using energy efficient technology and processes can help companies to save as much energy, save as much money, and lessen their impact on the environment. Enhanced lighting, heating, cooling and building technologies make it simpler for businesses to reduce their carbon footprint without compromising

performance. Perhaps the biggest improvement on energy efficiency has been in creating smart technologies, or systems that utilise sensors, data and automation to conserve energy. For instance, smart thermostats can adjust the temperature and heat of office spaces based on occupancy, so there is no energy wastage when no one is inside. Smart lights can modulate the light based on the time of day or the amount of natural light and save on electricity. Besides, building management systems (BMS) can monitor and manage energy consumption in large facilities through real-time information, which optimises HVAC, lighting, and other energy-intensive devices. Smart energy management systems can make businesses consume significantly less energy and leave a smaller carbon footprint. Siemens, Schneider Electric and General Electric lead in the creation and roll-out of smart energy solutions that allow companies to optimise energy use and emissions.

5.7.5 SUSTAINABLE MANUFACTURING TECHNOLOGIES

Another sector in which green technologies are contributing to the decrease of the environmental footprint is manufacturing. ‘Sustainable manufacturing technologies are all about eliminating waste, maximizing resource efficiency, and saving energy during production. This consists of renewable energy, waste reduction, and industrial emissions. 3D printing (also called additive manufacturing) for instance is starting to be used as an eco-friendly alternative to manufacturing. 3D printing requires the minimum amount of material to produce a particular item, so less material goes to waste and more can be recycled. Moreover, 3D printers can make parts and components in the same day, so no large inventory is required and there is less transportation emissions for the supply chain. Similarly, modern manufacturing processes like precision manufacturing help companies produce goods with more precision and fewer defects that reduce waste. There are also green packaging alternatives like biodegradable or recyclable materials that are increasingly being adopted by food and beverage, cosmetics and online commerce sectors. They are green-focused inventions that make companies more sustainable and consumers more sustainable.

5.8 CONTRIBUTION OF SUSTAINABLE INNOVATIONS TO EMISSIONS REDUCTION AND ENERGY EFFICIENCY PROMOTION

Green technologies together are a game-changer when it comes to emission reduction and energy efficiency. Companies can also switch to renewable sources of energy, such as solar energy, to cut down on their carbon emissions – especially in relation

to fossil fuels. EVs are emission-free, so it won't be like driving a gasoline car all over again, which will also help make the world a cleaner place. CCS systems can capture and store carbon emissions in hard-to-decarbonize industries; energy-efficient technologies and smart systems optimise resources, minimising waste and energy use.

These innovations not only save the businesses green as well as money. Companies who adopt energy-saving technologies will save money on their energy costs, lower the operating expenses and boost the bottom line. Also, companies who are more sustainable will be more attracted to environmentally minded consumers, investors and partners, which increases brand recognition and long-term revenue. As the world becomes increasingly low-carbon, green technologies will still have a crucial role to play in helping corporations reduce carbon emissions and help meet the Paris Agreement targets. As technologies improve and governments support, green-tracking companies are not only saving the world but setting themselves up for a sustainable future.

5.9 CHALLENGES AND BARRIERS TO ADOPTING SUSTAINABLE TECHNOLOGIES

And since corporations are becoming aware of their environmental responsibility, a lot of companies are investing in green technologies. From green energy to energy-efficiency, electric cars and more, green technologies have a great deal of potential to eliminate carbon emissions, improve resource management and corporate accountability. But even though there are many advantages to investing in sustainable technologies, there are several challenges and challenges for enterprises to make this work at scale. These obstacles can be anything from financial and technical challenges, regulatory limits and organisational incapacity. This is where learning the challenges to scaling up to sustainable technologies and learning how to navigate through these are important for organizations looking to adopt sustainability into their business operations.

5.9.1 UNDERSTANDING WHAT BUSINESSES NEED TO DO TO MAKE GREEN TECHNOLOGIES WORK FOR YOUR BUSINESS

- **Financial Costs and Investment Challenges:** The biggest barrier to the entry of sustainable technologies is the high upfront investment. Most green solutions (solar panels, electric cars, smart devices, carbon-storage) take up a great deal of upfront money. These upfront expenses can be very expensive for small and

medium-sized enterprises (SMEs) in particular. Even if these technologies will save you money over time through lower operating expenses (i.e., energy and repair costs), upfront costs are often a barrier to entry. Installing a solar system, for example, or buying electric vehicles for a fleet can be huge investments, and that's something that some businesses struggle with. The same goes for installing energy-saving technologies like advanced BMS or smart manufacturing systems, which usually involves high costs to install and also special training, maintenance, and support. The capital barrier is higher in the region or industry where there is less access to capital or where the business environment is shaky. For instance, startups in developing countries or who do not have access to green financing could find it hard to obtain funds to invest in green technologies.

- **Technological Barriers and Complexity:** Green technologies are a messy breed that need to be implemented and mastered. Many companies are not able to fully implement these technologies into their existing workflows because of technology hurdles. To give an example, if a company wants to use renewable energy sources like solar panels, wind turbines, or geothermal energy, they can have to completely redesign their infrastructure. Existing companies with older facilities or processes might not be able to replace those processes with new green technology.

  Additionally, some green technologies (eg, carbon capture and storage (CCS) are in development and potentially not commercially viable). Businesses might be reluctant to invest in technologies that have not been scaled yet or whose price point is still uncertain. Further, green technologies integration in existing business processes can require expertise in energy management, environmental engineering, supply chain management, and can be another obstacle for organizations that don't have the in-house capacity.
  And, for those in highly regulated fields (like drugs or chemicals), it might be even harder to adopt green technologies that meet safety, regulatory, and quality standards. The technical difficulty of using these technologies hampers adoption and takes a lot of time and effort to iron out.
- **Regulatory Constraints and Policy Uncertainty:** Limitations on regulation and policy uncertainty are the biggest obstacles for companies that want to move toward sustainable technologies. Green technologies regulatory landscape is still developing in many places. Subsidies or tax credits are possible from the government for renewable energy infrastructure, energy efficient appliances or electric cars — depending on politics, regional planning and budget. Companies might not be willing to invest in green technologies if they don't know whether

government subsidies are going to hold over the long term or are worried that policy changes will hurt their investment.

Moreover, enterprises may struggle to navigate environmental rules in some industries, especially those with strict compliances. Companies in manufacturing, energy or chemical sectors, for instance, could have to comply with emissions, waste management and environmental reporting. These rules are good for the environment, but it can be really challenging for companies to rapidly adopt green technologies without finding themselves in a compliance hell. Even in countries where regulations are not standardized it can be a barrier especially for multinational corporations. Environmental standards differ across countries or regions and could force corporations to change the way they do business, complicating and expensive the sustainability effort. Complying with various regulatory landscapes can be a challenge for businesses with the aspiration to have a global sustainable plan.

- **Cultural Resistance and Organizational Inertia:** The green technologies adoption can also face cultural resistance in the organization itself. Employees, management and other stakeholders can be stubborn – especially if the benefits of sustainable technologies don't always seem to be obvious or tangible. For instance, upper management might consider green technology investments to be dangerous in areas where margins are thin or returns are uncertain. What's more, employees who are used to working in the same process or technologies might be resistant to adjusting to change, particularly if transitioning to sustainable technologies feels disruptive or expensive. Green technologies can be delayed by organisational inertia (resistance to transformation based on an ingrained habit or pattern). If companies already use methods that have been proven, then it can be difficult to migrate to sustainable approaches if these approaches mean significant changes to the supply chain, production or product design. And, in some cases, the perceived barrier of entry when implementing sustainable technologies leads to a "wait and see" mentality, with companies holding off on investing in green technologies until they're 'mainstream' or until someone else does it.

What's more, not all businesses have the expertise and resources in-house to make the shift to sustainability. Going green means often working across teams of operations, finance, HR, and procurement. And for companies where sustainability is not woven into the corporate culture or strategic roadmap, this silo of communication can be impediments to transformation.

5.10 FUTURE TRENDS: THE INTERSECTION OF SUSTAINABILITY, TECHNOLOGY, AND INNOVATION

As the world transitions to a cleaner future, businesses are starting to understand that they need to integrate sustainability into their business processes and plans. Sustainability, technology and innovation are all now increasingly reshaping industries, opening up new businesses, and redefining corporate business. Technological change allows companies to become more sustainable, more creative and meet the ever-increasing pressure for sustainability on the part of consumers, investors and regulators. Here, staying abreast of the trends and what is to come for CSR is imperative for organizations that wish to be competitive and ethical in a dynamic global marketplace.

5.10.1 CIRCULAR ECONOMY AND SUSTAINABLE PRODUCTION

Perhaps the biggest recent emergence in sustainable business is the circular economy. In an old linear economy, goods are produced, consumed and destroyed, producing waste and destruction. A circular economy, by contrast, is designed to make the loop smaller by reusing, recycling and repurposing products and materials to reduce waste and resource use. It is a sustainable-production, responsible-consumption, product lifecycle management-oriented model. We are already seeing technological solutions to allow the companies to move towards the circular economy. Technology innovations like advanced waste sorting and materials recovery are making it much easier to re-use previously lost products. More, companies are also using digital tools such as blockchain and IoT to monitor the life cycle of products and recycle or reuse materials at the end of their use-life. In the circular economy, companies save the environment, lower operating costs and generate new revenue from re-purposed goods or services. The fashion industry, for instance, is also making more and more moves towards circular fashion – using recycled materials, designing for long life, and having take back options for recycling or upcycling garments. Electronics companies are also looking at recycling materials such as lithium and cobalt from obsolete equipment, a more sustainable supply chain for the precious raw materials.

5.10.2 SUSTAINABLE SUPPLY CHAINS AND TRANSPARENCY

As customers and regulators insist on more visibility across the supply chain, manufacturers rely on technology to monitor and verify the longevity of their goods from the origin of the raw material to disposal at the end of life. Blockchain, AI, IoT,

and more technologies are enabling companies to develop more sustainable and transparent supply chains. Blockchain technology, for example, helps businesses to know where materials and final goods came from and how they're made, that they're sourced fairly, manufactured responsibly and shipped with the minimum of impact on the environment. AI and machine learning also allow companies to enhance supply chains, cutting waste, optimising resources and reducing carbon emissions. Demand prediction with AI, for instance, allows companies to anticipate product demand better, which leads to less overproduction and overstock. This in turn reduces waste and ensures resources are better used throughout the supply chain. Businesses such as Unilever, Walmart and Patagonia already use the latest technologies to make their supply chains more sustainable. These companies can trust their customers more and have sustainability measures to ensure they conform to global environmental standards using blockchain to trace the origin of their goods and source ethically.

5.10.3 Decarbonization and Renewable Energy Adoption

There is also the rise of renewable energy as a technology in the field of energy generation, storage and management, that is promoting greater use of renewable energy sources. Renewable energies like solar, wind, and geothermal are all cheaper and available as companies look to decrease their carbon footprints. Solar energy, in particular, has experienced dramatic efficiency and cost reductions, and it is something any business of any size could be on board with. In addition, energy storage systems – advanced batteries and grid-scale storage systems – are making renewable energy more reliable and scalable. Today, companies can store surplus renewable energy during low demand times and draw it from it at demand times to keep an uninterrupted, reliable energy supply that doesn't depend on fossil fuels. The companies such as Tesla, Google, Amazon, and many others are investing in renewable energy and will continue to operate on 100% renewable electricity. And not only are these companies pushing the renewables revolution, they are energizing other industries to follow suit and drive the decarbonization of the world.

5.10.4 SUSTAINABLE MOBILITY AND SMART TRANSPORTATION

One of the biggest causes of global emissions is transport, and organizations are looking for alternative modes of mobility that are sustainable in order to save the planet. Electric vehicles (EVs) and self-driving vehicles (AVs) are leading the charge in this change. EVs are getting cheaper, battery technology is improving range and lowering charging times. The logistics and delivery companies like Amazon and

FedEx already invest a lot in the electric delivery vehicles to help cut emissions and maximize fleet efficiency.

Then there's the IoT backed smart transport solutions for businesses that are rearranging vehicle fleets and using less fuel. Fleet management systems powered by IoT let companies know the performance of their vehicles on the road, their usage of fuel and their maintenance requirements in real time, helping cut transportation emissions. But even the proliferation of electric public transport and mass mobility (electro scooters, bikeshare etc.) is helping to ensure sustainable mobility by eliminating the need for gasoline-driven vehicles.

5.10.5 PRODUCT DESIGN THAT DOESN'T USE ENERGY AND NATURAL FIBERS

A company's entire environmental footprint is largely determined by how products are designed. Because people are more and more demanding of eco-conscious products, companies are using sustainable design and materials. Material science is allowing firms to create environmentally sustainable materials that are biodegradable, recyclable or renewable. For instance, biodegradable packaging made of plants are replacing plastics used for one purpose in food and beverage, cosmetics and retail. Sustainable design is also being adopted by businesses such as IKEA and H&M that design products that are modular, durable and recyclable. Also, sustainable materials like bamboo, hemp, organic cotton are increasingly being used in fashion, furniture and construction. Companies can avoid the need to use plastics and waste as much as possible, and give consumers sustainable options by creating products that are sustainable. Sustainable product design not only saves businesses from CO2 but also makes them stand out in a market increasingly dominated by green products demand.

5.11 REFERENCES

- Andersen, M. S., & Skjoett-Larsen, T. (2020). *Sustainability and supply chain management: Integrating environmental and business goals*. Springer Nature.
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production, 65*, 42-56. https://doi.org/10.1016/j.jclepro.2013.11.039
- Elkington, J. (1997). *Cannibals with forks: The triple bottom line of 21st-century business*. Capstone Publishing.

- Hargroves, K., & Smith, M. (2005). *The natural advantage of nations: Business opportunities, innovation and governance in the 21st century*. Earthscan.
- Hart, S. L., & Milstein, M. B. (1999). Global sustainability and the creative destruction of industries. *Sloan Management Review, 41*(1), 23-33.
- Porter, M. E., & Kramer, M. R. (2006). Strategy and society: The link between competitive advantage and corporate social responsibility. *Harvard Business Review, 84*(12), 78-92.
- Ray, S., & Smith, J. (2019). *Technological innovations for sustainable business models*. Springer.
- Seuring, S., & Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production, 16*(15), 1699-1710. https://doi.org/10.1016/j.jclepro.2008.04.020
- UN Global Compact. (2020). *Business and sustainable development: A guide for companies*. UN Global Compact.
- Whelan, T., & Fink, C. (2016). *The business guide to sustainability: Practical strategies and tools for organizations*. Earthscan.