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ADAPTING TO SUSTAINABILITY: NAVIGATING THE OBSTACLES OF TECHNOLOGICAL SHIFTS IN GREEN ECONOMY

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ABSTRACT

The transition to green and inclusive economies has been deliberated both at national and global level. India has initiated with 2 major global commitments: the 2030 Global development Agenda and ratification of Paris Agreement. This paper is basically focusing on Green Economy with technological shifts, economic hurdles in adapting green economy. A development plan known as the "green economy" combines ecological sustainability with economic growth. The stated goals of environmentally friendly sustainable measures have, up until now, mostly not been achieved in developing nations because of factors like the pressing need for fundamental development priorities, a dearth of funding from the developed world for adaptation and mitigation needs, etc. India is dealing with the issue of trying to address climate change head-on while implementing a traditional economic growth strategy and making haphazard attempts to prepare the economy. It was discovered that the current production and consumption system is unable to support development in a way that is truly sustained and sustainable in the context of current globalization. Adopting the multifaceted Green concept will have an impact on business, employment, trade, agriculture, and domestic industries. As a result, there will be a need for significant fiscal reforms, skill development, political stewardship, public awareness, and vigilance regarding changing international trade relations and trade patterns. Encouraging infrastructure and manufacturing decisions with a thoughtful consideration of sustainability can pave the way for India's economy to transition to a green economy.

KEYWORDS

Green Economy, Sustainable Development, Ecological Sustainability, Economic Development, Technological shifts

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INTRODUCTION

What is Green economy?

The green economy is defined by the United Nations Environment Programme (UNEP) as one that results in "improved human well-being and social equity, while significantly reducing the environmental risks and ecological scarcities" or "a low carbon, resource efficient and socially inclusive economy." The ideas of sustainability and the "green economy," which emphasize social justice, economic viability, and environmental responsibility, are related.

Meeting current requirements without sacrificing the capacity of future generations to meet their own needs is referred to as sustainability. It entails a methodical strategy that considers economic, environmental, and social aspects. Practices that support renewable resources, lessen environmental damage, and guarantee the long-term viability of ecosystems are frequently included in sustainability initiatives. The interrelated issues of poverty, inequality, climate change, environmental degradation, peace, and justice is the focus of sustainable development. It takes a comprehensive strategy that takes into account the long-term impacts of human activity on the environment and aims to strike a balance between social progress, environmental preservation, and economic growth.

A number of international programs, including the Sustainable Development Goals (SDGs) of the United Nations, have been set up to give nations and organizations a framework for cooperating to address different facets of development in order to achieve a more sustainable future.

In order for progress to be genuinely sustainable, it must be made without depleting natural resources or harming the environment, guaranteeing that future generations will be able to satisfy their own requirements and prosper. This is the premise of sustainable development.

IMPORTANCE OF ADAPTING TO TECHNOLOGICAL SHIFTS

In the framework of the green economy, it is imperative to adjust to technological changes for a number of reasons, including the fact that they have a substantial impact on sustainability, economic growth, and societal well-being. The following are some salient points emphasizing how crucial it is to adjust to technology changes in the green economy:

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Environmental Conservation: The development of sustainable solutions that lessen their influence on the environment is greatly aided by technological breakthroughs. Green technologies assist reduces carbon emissions, minimize pollution, and conserve natural resources. Examples of these technologies include energy-efficient equipment, sustainable materials, and renewable energy sources (solar, wind, and hydro).

Economic Growth: Embracing the green economy's technical advancements can result in the emergence of new markets, industries, and employment possibilities. While lowering dependency on finite resources and fossil fuels, innovations in clean transportation, waste management, renewable energy, and sustainable agriculture stimulate economic growth.

Resource Efficiency: The creation of more effective procedures for the use of resources is made possible by technological developments. This covers waste reduction in the manufacturing and production processes, material recycling and upcycling, and energy optimization.

Mitigation of Climate Change: Using innovative technologies is essential to reducing the effects of climate change. One of the main causes of global warming is greenhouse gas emissions, which are reduced with the use of green technologies. Technology developments in energy storage, smart grids, and electric cars help reduce carbon emissions.

Regulatory Compliance and Market Demand: Businesses must adjust to technical changes in the green economy as environmental rules become stricter and customer demand for sustainable goods and services rises. Gaining a competitive edge can come from achieving customer expectations and staying ahead of regulatory obligations.

Resilience and Future-Proofing: Putting money into sustainable practices and green technologies makes one more resilient to environmental threats. Companies and societies that accept these changes will be better able to adjust to the changing environmental conditions, lowering their vulnerability to resource constraint and climate change.

Global Leadership and Collaboration: Countries and organizations may play a leading role in international efforts to mitigate climate change by embracing technical advancements in the green economy.

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Public Health and Well-Being: By lowering air and water pollution, green technologies and practices benefit public health. Healthy living circumstances are a result of clean energy sources and sustainable activities, and this has a favourable effect on both communities and individuals.

It has been a common assertion during the past ten years that major social and economic issues, such as water scarcity, biodiversity loss, and climate change, require reforms to the conventional economic models. This discussion was sparked by the global financial crisis of 2008–2009, and the idea of a "***green economy***" was born out of these worries. Moreover, the so-called 2030 Agenda for Sustainable Development, which includes Sustainable Development Goals, was adopted by nations worldwide in 2015. These objectives acknowledge that addressing social needs such as health, employment creation, education, and social protection—as well as addressing environmental pollution and climate change—must coexist with policies aimed at fostering economic growth. Thus, the natural system and the economic system are actually linked by the sustainable development goals. Additionally, they emphasize how important it is to make the shift to a green economy, or a more sustainable manner of production and consumption.

Many scientists believe that technology will help us move toward a carbon-neutral future. Even though climate change is receiving more attention these days, attempts to use technology to find a solution are not new. Following the crash, green tech in 2001 provided tech investors with a fresh avenue for investment, which sparked a wave of capital investment in start-ups focused on renewable energy, such as Bloom Energy, which was named a Technology Pioneer in 2010.

Tech start-ups have only increased their focus on climate change over the last 20 years. These days, a lot of efforts to mitigate the effects of climate change go far beyond using sustainable energy. Carbon capture technology has been rolled out by a number of start-ups, including Carbon Engineering and Clime works from this year's Technology Pioneers. These innovations eliminate CO2 from the atmosphere.

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THE GREEN ECONOMY: HISTORICAL PERSPECTIVE

With growing knowledge of the effects that economic activity has on the environment, the idea of a "green economy" has changed over time. The concept of incorporating sustainable development and environmental preservation into economic activities has a long history that begins with a number of movements and events:

Early Conservation Movements: Concerns about deforestation, protecting animals, and the effects of industrialization on the environment led to the formation of environmental conservation movements in the late 19th and early 20th century. The significance of protecting natural areas was emphasized by movements like the creation of Yellowstone National Park in 1872 and notable individuals like John Muir in the United States.

Rise of environmental Awareness: By the middle of the 20th century, environmental challenges were being understood on a global scale. The 1962 release of Rachel Carson's book "Silent Spring" and other related events sparked worries about pesticide use and its effects on the environment. As a result, the contemporary environmental movement was born, and environmental protection became more widely recognized.

UN Conferences and Agreements: The UN was instrumental in elevating environmental issues to the top of the international agenda. A historic occasion, the Stockholm Conference of the United Nations on the Human Environment in 1972 set the foundation for global environmental cooperation.

Sustainable Development: The World Commission on Environment and Development's 1987 Brundtland Report introduced the idea of sustainable development. According to this research, sustainable development is development that satisfies current demands without jeopardizing the ability of future generations to satiate their own.

Rio Earth Summit (1992): Held in Rio de Janeiro, the United Nations Conference on Environment and Development was a turning point in the advancement of environmental protection and sustainable development. It led to the formation of organizations such as the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change (UNFCCC), and Agenda 21.

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Concept of the "Green Economy": The phrase "***green economy"*** became well-known as a possible way to strike a balance between environmental sustainability and economic growth. It highlights how crucial it is to use resources wisely, cut down on waste and pollution, and support sustainable and renewable energy sources.

Subsequent Agreements and Movements: The commitment to address climate change and make the transition to a low-carbon economy was further reaffirmed by subsequent international agreements, such as the Paris Agreement in 2015. Concurrently, there has been a growing emphasis on sustainability, renewable energy, and ethical business practices in both corporate projects and grassroots organizations.

To sum up, the development of the green economy is closely linked to the historical advancement of environmental consciousness, worldwide movements, and international accords that aim to strike a balance between economic expansion and preservation of the environment.

TECHNOLOGICAL SHIFT IN GREEN ECONOMY

Role of Technology in Sustainability

"Sustainability can't happen without a lot of technology enablement and, therefore, a lot of support from technology leaders," said Bruno Sarda, TMT climate change and sustainability services leader at EY. "When CIOs look at their priorities, sustainability should cut across all of them."

Technology is essential to the advancement of sustainability initiatives in many different fields. The following are a few ways that technology supports sustainability:

Renewable Energy: The efficiency and availability of renewable energy sources, such as solar, wind, hydro, and geothermal power, have greatly increased because to technological breakthroughs. As a result of advancements in energy storage technologies, wind turbine efficiency, and solar panel design, these renewable energy sources are now more widely available and affordable, which lessens the need for fossil fuels and greenhouse gas emissions.

Energy Efficiency: Better energy management in buildings, transportation, and industries is made possible by smart technologies and Internet of Things (IoT) devices. Smart meters, automated systems, and energy-efficient appliances all aid in tracking and optimizing energy use, cutting waste, and advancing sustainability.

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Clean Transportation: The transportation sector's carbon emissions are reduced by electric vehicles (EVs) and hybrid cars, as well as by developments in battery technology and charging infrastructure. Additionally, route optimization and energy conservation are the goals of advancements in autonomous cars and transportation logistics.

Technology helps in waste management by improving waste sorting, recycling, and waste-to-energy methods. Cutting-edge composting methods, waste sorting strategies, and recycling technology all contribute to a circular economy by minimizing the environmental impact of trash.

Water Conservation: Smart irrigation systems, water purification and desalination technologies, leak detection systems, and effective water management solutions are just a few of the innovative technologies that help conserve water and ensure its responsible usage.

Precision Agriculture: Precision agriculture maximizes agricultural yields while using less resources by utilizing sensors, data analytics, and artificial intelligence. This includes using pesticides, fertilizers, and water strategically to reduce environmental impact and boost productivity.

Conservation and Monitoring: Drones, satellite imagery, and remote sensing technologies are some of the tools used to monitor and safeguard ecosystems. With the use of these tools, decision-makers may better monitor environmental changes, wildlife conservation efforts, and deforestation, ultimately leading to the preservation of biodiversity.

Circular Economy Solutions: Technology that makes it possible to recycle, repurpose, and remanufacture materials and products helps to realize the idea of a circular economy. From research on sustainable materials to 3D printing, these inventions reduce waste and encourage resource efficiency.

Blockchain for Sustainability: Especially in sectors like electronics, food, and fashion, blockchain technology guarantees transparency and traceability in supply chains, confirming the genuineness and sustainability of products.

Education and knowledge: The use of technology is essential to raising public knowledge of sustainability-related issues. People are educated and motivated to adopt more sustainable habits and behaviours through the use of social media, educational platforms, and other digital tools.

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Future developments toward a more ecologically friendly and sustainable state are greatly aided by the way these technical innovations are incorporated into different facets of our existence. But it's imperative to make sure that these technologies are created and applied with sustainability at its core, taking into account the effects of their life cycle and guaranteeing fair distribution and access.

ECONOMIC HURDLES IN ADOPTING NEW GREEN TECHNOLOGIES

1. Overcoming a number of significant obstacles is necessary to realize the energy transition.
2. These include financial issues, technological constraints, and geopolitical worries.
3. Is a hybrid strategy that makes use of both renewable energy sources and fossil fuels the solution?

CHALLENGES IN ADAPTING TECHNOLOGIES

a. handling diffuse environmental risks that are becoming more and more global
b. bringing about radical sustainable technological change rather than just incremental changes;
c. green capitalism and the uncertain state of business as usual;
d. the role of the state and creating suitable policy mixes; and (e) handling distributional concerns and impacts.

CASE STUDY ANALYSIS

As of my last knowledge update in January 2022, I can provide some key legal cases and precedents that are related to adapting to sustainability and the obstacles faced in technological shifts within the green economy. However, case law specifics can often be vast and might vary based on jurisdictions and ongoing developments post my last update.

Massachusetts v. Environmental Protection Agency (2007):

This case is significant in the context of sustainability as it addressed the regulation of greenhouse gas emissions. The Supreme Court ruled that the EPA has the authority to regulate emissions of greenhouse gases under the Clean Air Act. This decision established the legal basis for the government's role in addressing climate change.

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U.S. Steel Corp. v. Natural Resources Defense Council (2007):

In this case, the issue of what constitutes "best available technology" under the Clean Water Act was addressed. The decision emphasized the importance of using the best available technology to limit environmental harm and the role of legal obligations in pushing for more sustainable technological solutions.

Juliana v. United States (Ongoing):

Although not finalized as of my last update, this case has significant implications for climate policy. A group of young people sued the federal government, arguing that it had violated their constitutional rights by not taking sufficient action to prevent climate change. This case highlights the legal responsibility of governments in addressing environmental issues, especially for the benefit of future generations.

When it comes to the obstacles of technological shifts in the green economy, there might not be specific case laws, but legal challenges often stem from various aspects such as:

Patent Issues and Intellectual Property: Legal battles surrounding patents can hinder the adoption of new green technologies by limiting their availability or making them more expensive.

Regulatory Barriers and Standards: Ambiguities or stringent regulations in different jurisdictions can impede the swift adoption of green technologies.

Disputes Over Liability and Responsibility: When new technologies are introduced, questions about liability in case of failure or environmental damage might arise. Legal clarity is crucial to encourage innovation.

Economic Implications and Subsidies: Legal battles sometimes emerge regarding government incentives, subsidies, or regulations that either support or hinder the adoption of green technologies.

While these cases offer some insights into the legal landscape surrounding sustainability and technological shifts in the green economy, it's important to stay updated with ongoing developments and emerging cases as environmental laws and regulations continue to evolve.

ECNOMIC PERSPECTIVE ON SUSTAINABILITY

Economic Theories for analysing sustainability

An overview of sustainability and sustainable development theories and concepts, as well as any predicted connections to the world's current environmental, social, and economic crises. The

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theory of climate change is examined, along with its potential effects on natural resources and their ability to promote sustainable economic development. A thorough examination of the definition and types of sustainability as well as the sustainable development paradigm is given. We also include an overview of the Natural Capital, Natural Steps, and Factor X rules and definitions because they are pertinent to the topic of environmental sustainability. It is discussed how scenario-based analysis has been effectively applied to the creation of strategic planning exercises and sustainability-related policies, rules, and regulations. His ideas of economic, social, and environmental sustainability, support the idea of practical sustainability, which is defined as an integrated strategy for long-term environmental sustainability.

he House of Random "Environment" is defined by Webster's College Dictionary as the totality of the circumstances, influences, and objects that surround oneself.

The environment encompasses social and cultural influences in addition to the air, water, minerals, creatures, and other external elements that surround and impact a particular organism. The biological field that studies the interactions and relationships between living things and their natural environments is referred to as ecology.

The potential for both internal and external, natural and man-made forces to alter the environment and ecology includes things like extreme air and water pollution, droughts, floods, deforestation, and land degradation brought on by natural disasters, wars, or changes in political and social structures. For instance, one of the main contributing factors is thought to be the pollution caused by heavy metals, particularly lead.

The noted alterations and transformations in the environment and ecology have also been connected to the industrial revolution and economic expansion. However, the biophysical, geographical, social, cultural, and economic circumstances, as well as the intensity of the use of resources and energy and the release of industrial pollutants into the environment, all influence the rate and characteristics of these changes. As might be expected, economic growth leads to increases in the production and consumption of goods and services as well as the production of various pollutants, waste products, and byproducts on a variety of scales. The "nature of variation" in the features, health, and environment's capacity to absorb emissions, as well as the "pollution patterns," are two significant aspects of the interplay between pollution and natural environmental resources.

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COST BENEFIT ANALYSIS OF TECHNOLOGY

The comparative method and analytical tool known as CBA are especially popular when evaluating public infrastructure projects. In the public sector, the public's profit is more important than investors' profits. The foundation of CBA is the analysis of all costs and benefits, both explicit and implicit, which measures the societal effects of investments. The net socioeconomic surplus of the society, or a portion of it, serves as the evaluation criterion. The purpose of the CBA is to prove the company's suitability and to facilitate a more efficient use of resources. An economic evaluation method known as an extended cost-benefit analysis looks at costs and benefits for all parties involved, including social, economic, and environmental ones.

In an environment where externalities, public goods and other market imperfections are frequently overlooked record. The public and private sectors benefit from using eCBA by being more knowledgeable when coming to judgments. Not just that choice Producers will be able to see projects' true costs with greater clarity, but also the advantages of eschewing these expenses. These detrimental effects cascade down an impact pathway or a causal chain. Among the often-mentioned examples are deforestation and improper land management practices. Typically, only revenues, O&M, and capital expenses are taken into consideration when making investment decisions. Changes in land use, however, also affect the quality of ecosystem services and have biophysical effects. The values of the services that are used by different stakeholders are impacted by these effects in turn. Project appraisals and investment plans often overlook these values.

There are currently few regulatory incentives and sanctions for many projects—whether carried out by state-owned or private companies—that require careful consideration of integrating environmental costs into project planning. Consequently, unrecorded external expenses incurred during the manufacturing process manifest subsequently as societal remediation expenses. Governments can create policies and regulations to impose costs on polluters using an evidence-based platform if these costs are known and measurable. Stated differently, it is imperative to internalize and monetize these implicit expenses.

The CBA can be applied to more general analyses as well as to a particular investment proposal. The phrase "project-level CBA" refers to the application of CBA to specific investments and projects. Depending on the scale of the project, a project-level CBA can cover a variety of regions and time periods due to its flexible scope. The project level e CBA is also applicable to various

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users in various industries. Although the main goal of the e CBA is to facilitate project design or redesign in order to better achieve the intended results, policy implications for each of the five desired outcomes of Indonesia's green growth can also be drawn using this tool. Specifically, there are four main applications of CBA that can influence green growth planning and policy:

1. As rationale for modifying public policy
2. As a method for quantifying current or suggested policy incentives
3. As a means of setting policy priorities for green growth
4. As a means of verification prior to the adoption and execution of policies

HURDLES AFTER COVID-19 PANDEMIC

Adoption of improvements and green technology help firms in reducing operating expenses, improvement of profit margins and productivity of the employees. After unpredictable COVID-19 and high energy prices, So some European business has an opportunity to recover with net zero targets with adoption of green technology.

Also, COVID-19 led to uncertainty and unpredicted levels related to financial distress concerned with higher certainity level regarding the future with lesser employment and investments. Therefore, the firms face higher uncertainty in financial situation and it is likely less to invest in energy efficient technologies. It suggests government to support firms by affecting private investments for stimulating more updates of green technology and investments for efficient energy technology.

In addition to being bad for the economy, uncertainty could also present a chance for technical advancement. Previous research has clearly shown that technological innovation can effectively reduce uncertainty between nations. It is unknown, nevertheless, if this uncertainty can spur innovation internationally. Therefore, we create an empirical model in this study to investigate how uncertainty affects technological innovation over the course of 2013–2018 in a global panel of developed and developing nations. The fact that developed countries should recognize that uncertainty is a workable approach for addressing innovative ideas, while developing countries must take decisive action to view uncertainty as a key to unlocking opportunity, has important ramifications.

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CONCLUSION

In the green economy, adjusting to sustainability and overcoming the challenges posed by technological advancements is a complex task that calls for a methodical and cooperative approach. In conclusion, this endeavour highlights a number of important points:

1. **Technological Shifts:** Adapting to these changes is crucial if we are to meet sustainability targets in the green economy. Technology innovation is essential to finding better, more effective solutions, lessening the impact on the environment, and building a more sustainable future.
2. **Adoption Challenges**: Making the switch to sustainable technologies is not without its difficulties. Progress may be hampered by issues like high upfront costs, reluctance to change, and the requirement for significant infrastructural improvements. Successful adaptation requires an understanding of these issues and taking appropriate action.
3. **Collaborative Efforts**: Governments, corporations, academic institutions, and communities must all work together in order to achieve sustainability. In order to overcome obstacles and promote a shared commitment to sustainability, public-private partnerships, information sharing, and cooperative initiatives are essential.
4. **Policy and Regulatory Frameworks**: Governments are essential in creating an atmosphere that is favourable to long-term technological advancements. Businesses can invest in green technologies by being encouraged by clear and supportive policies, regulations, and incentives, which will lead to widespread adoption and innovation.
5. **Investment in Research and Development**: To promote technological innovation, research and development must be continuously funded. This involves providing funds for the study of green technologies, creating novel, environmentally friendly solutions, and improving already-existing technologies to make them more widely available and economically viable.
6. **Education and Awareness**: Key elements of a successful adaptation are raising public awareness and teaching people about the advantages of sustainable technologies. Promoting a mentality shift in favour of sustainable practices is part of this, both for individuals and for organizations.
7. **Global Cooperation**: International cooperation is necessary to address the global challenge of sustainability. Global exchange of resources, technologies, and best practices can quicken the pace of transition to a green economy and guarantee that no country is left behind.

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8. **Resilience and Flexibility**: Unexpected obstacles might appear on the dynamic path to sustainability. To navigate uncertainty and adjust to changing conditions, technological adaptation strategies must incorporate resilience and flexibility.

In conclusion, a comprehensive and cooperative strategy that incorporates technological innovation, supportive legislation, education, and international cooperation is required for successfully adjusting to sustainability in the green economy. Societies can set the path for a future that is more environmentally conscious and sustainable by embracing change and overcoming obstacle.

Research on multiple impact evaluations, including innovative methods in evaluation studies, should be beneficial to the shift to a green economy. The assessments of the effects of significant baseline trends, such as automation and digitization, globalization versus nationalization, etc., on distributional and environmental outcomes as well as the potential for partnerships in green innovation and different business models influenced by the circular economy. These assessments may be especially important for comprehending potential future directions for the decarbonization and greening of important process industries. It is obvious that better assessments of policy tools and policy combinations are also required. Such assessments are far from simple, with a greater focus on the function of technology-specific policies. They must address significant interaction effects and take into account the various policies' roles in the innovation systems.

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