Sustainable and Fair Technology for an Equitable Society

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ABSTRACT

Technological innovation has great potential to solve global problems, but its implementation must be carried out with attention to environmental sustainability and social justice. Technology that is not designed with consideration for both aspects can exacerbate social inequality, damage the environment, and create disparities in access to resources. Therefore, policies are needed to guide the development and application of technology with principles of sustainability and justice, to ensure that its benefits can be felt by all layers of society. A more inclusive and sustainability-based approach can make technology a tool for creating relevant, fair, and responsible solutions. This involves collaboration between the government, technology developers, and society in formulating policies that promote environmentally friendly technology, accessible to many, and do not endanger individual rights. The sustainability of technology is not only related to economic efficiency or technical advancement but also to the moral and ethical aspects that are crucial for achieving collective well-being. The implementation of fair and sustainable technology is a key factor in realizing a better and more sustainable future.

INTRODUCTION

In recent decades, technological innovation has become a major driving force in the development of various sectors, including the environmental sector. New technologies, such as renewable energy, electric vehicles, and waste processing technologies, show great potential in reducing negative impacts on the environment (Qamar, 2021). However, despite these innovations offering opportunities for sustainability, challenges remain in their widespread implementation. Technology can offer solutions that reduce carbon emissions, save energy, and improve resource efficiency, but there are often issues in the adoption of this technology at both global and local levels, whether due to costs, inadequate infrastructure, or limited understanding of the long-term benefits (Ulucak, 2021). These adoption barriers are further exacerbated by unequal access to technology and varying levels of digital skills among different communities, which are critical issues in the digital age (Arifin & Darmawan, 2021).

Various countries have attempted to adopt policies that leverage technological innovations to achieve sustainability goals (Rajan & Sushil, 2022). For example, the use of renewable energy has been introduced in various countries as a step to reduce dependence on fossil fuels. Environmentally friendly technology is also increasingly being promoted to replace industrial practices that harm nature. he development and application of such technology must be guided by ethical and fair principles to ensure it serves the broader public good and does not create new forms of inequality (Radjawane & Mardikaningsih, 2022). However, the adoption of this technology does not always go smoothly, and in some cases, the desired positive impact is not effectively achieved (Tabrizian, 2019). Moreover, policies supporting green technology are often still hindered by various political, economic, and social factors (Show et al., 2018), highlighting the need for coherent public policies that actively build a balance between economic, social, and environmental pillars (Mardikaningsih & Hariani, 2021).

On the other hand, there is also the issue of technological innovation that can actually worsen environmental conditions (Vanden Berg, 2013). For example, the increasingly advanced production of electronic devices, while driving efficiency in various sectors, also generates electronic waste that pollutes the environment. The use of technology in industries

that do not consider long-term environmental impacts can cause more harm than good (Wang & Liu, 2020). Therefore, it is important to explore how technological innovations can be optimized in a way that is not only economically effective but also environmentally responsible. This exploration is central to formulating sustainable business strategies, especially in the face of regulatory uncertainty and complex managerial challenges (Mardikaningsih & Darmawan, 2021).

One of the main issues that arises is the imbalance between economic gains and environmental sustainability in the implementation of technological innovations. In many cases, technology that is developed and implemented rapidly does not always consider its impact on ecosystems or human well-being in the long term (Raudsepp et al., 2010). For example, the development of batteries for electric vehicles, although reducing greenhouse gas emissions, can contribute to other problems such as mineral mining that damages land and water (Zinchenko & Filenko, 2020). Therefore, there needs to be a more holistic evaluation of technology to ensure that the solutions presented are truly sustainable. This evaluation must include the vital role of local communities, whose knowledge and participation are crucial for effective environmental conservation and natural resource management (Ramle et al., 2022). Moreover, the adoption of environmentally friendly technology is often hindered by high costs and unequal access (Sovacool et al., 2022). Developing countries, for example, often face difficulties in implementing green technology due to high initial costs, lack of adequate infrastructure, and dependence on fossil fuel-based industries. On the other hand, although some developed countries have made significant investments in green technology, the success of adopting this technology is often limited by policy issues or industry resistance to change (Li et al., 2020). Thus, it is important to formulate policies that not only support innovation but also ensure that this technology is fairly accessible to all layers of society (Schot & Steinmueller, 2018).

The third issue that needs to be addressed is the lack of attention to the product life cycle and the long-term impact of technology. Although technology is often developed with the aim of increasing efficiency and reducing environmental impact, many of these innovations have the potential to create new problems that were not previously considered (Rosen et al., 2008). For example, the production of solar panels can reduce dependence on fossil fuels, but the manufacturing and recycling

processes of solar panels themselves can cause pollution and generate hazardous waste (Iravani et al., 2017). Therefore, in every technological innovation, it is important to ensure that the entire life cycle is considered to avoid creating new environmental problems. This principle aligns with sustainable policy directions in various sectors, such as tourism, which emphasize a holistic lifecycle approach to development (Tania & Sinambela, 2022).

It is important to understand the relationship between technological innovation and the environment because the impact of technology is not only seen in the short term but can also continue into future generations. Innovation that does not consider long-term impacts can cause irreversible damage to ecosystems and the quality of life of communities (Oksanen & Hautamaki, 2015). Therefore, the implementation of environmentally friendly and sustainable technology is essential to ensure that rapid technological development does not sacrifice the sustainability of the Earth. Moreover, policies that support green innovation need to be balanced with a deep awareness of the importance of maintaining the balance between technological advancement and environmental preservation.

The aim of this study is to explore ways in which technological innovation can be optimized to support environmental sustainability, taking into account social and economic impacts, as well as equitable access for all segments of society. This exploration necessitates a multi-dimensional approach that moves beyond technical efficiency. It requires an examination of how innovation can be systematically aligned with the principles of sustainable development, ensuring that advancements in areas like renewable energy, circular economy technologies, and green infrastructure deliver tangible ecological benefits while simultaneously fostering social inclusion and economic resilience. The optimization process must critically assess the entire technology lifecycle from design and raw material sourcing to deployment, usage, and end-of-life management to preempt and mitigate unintended negative consequences, thereby ensuring that technological progress contributes authentically to long-term planetary and societal health.

Furthermore, this study aims to identify potential issues that may arise from technology that is not fully sustainable and to develop policies that can support the fair and effective implementation of environmentally friendly technology. A key focus is diagnosing the risks of "green gaps" situations where well-intentioned technologies inadvertently

exacerbate social inequalities, create new forms of environmental degradation, or remain inaccessible to marginalized communities due to cost, infrastructure, or knowledge barriers. Based on this diagnostic, the research seeks to formulate robust policy frameworks. These frameworks should incentivize ethical design, promote inclusive stakeholder engagement particularly with local communities' mandate transparency and accountability in implementation, and create financing and capacity-building mechanisms that ensure equitable access. The ultimate objective is to contribute to a coherent governance model where policy, innovation, and equity converge to enable a just transition towards a sustainable future.

RESEARCH METHOD

The literature review approach is one of the effective methods in examining the topic of technological innovation and its impact on environmental sustainability. With this approach, researchers can collect, analyze, and critique previously published research findings to understand key concepts, existing debates, and emerging trends in the relationship between technology and the environment. The literature used in this study may include journal articles, policy reports, books, and other publications relevant to the examined theme. This allows researchers to construct a strong theoretical foundation for understanding how technological innovations can be applied sustainably.

Through literature review, researchers can also evaluate various approaches proposed by experts regarding environmentally friendly technological innovations and sustainability strategies. This method allows for the identification of the weaknesses and strengths of each approach that has been implemented in various countries or industrial sectors. For example, in the context of renewable energy use, literature studies allow researchers to analyze the success or failure of green technology implementation on both global and local scales. The results of this analysis will provide a deeper understanding of the factors influencing the implementation of environmentally friendly technologies and their implications for sustainability.

In this case, the literature review also allows researchers to identify gaps in the existing literature as well as areas that still require further research. By utilizing existing sources, researchers can produce a synthesis that enriches the scientific discourse on technological innovation and sustainability. This is very important for guiding public policy and industrial practices towards better directions, ensuring that the technologies applied are not only economically efficient but also environmentally and socially friendly. In this way, literature studies can make a significant contribution to understanding the relationship between technological innovation and environmental sustainability.

RESULT AND DISCUSSION

Technological innovation has become a major catalyst for global change, offering potential solutions to global challenges such as climate change, resource limitations, and social inequality (Ciplet et al., 2015). This orientation towards technology is also a key driver in building the competitive advantage of various economic actors (Putra & Darmawan, 2022). However, with the rapid development of technology, new challenges related to its application have emerged that need to be addressed in depth. One of the main issues that needs to be addressed is how to ensure that technological innovations not only focus on efficiency and profit but also consider environmental sustainability and social justice (Zinchenko & Filenko, 2020). The careless application of technology can exacerbate social inequality, worsen environmental damage, and trigger injustice in access to resources (Leal, 2019). significant factor in this regard is the optimal application of information technology, which requires adequate user skills to positively impact organizational performance (Djaelani et al., 2020).

Developing responsible technology requires awareness and wise policies at every stage, from design to field implementation. Environmentally friendly and socially just technology requires more than just sophisticated tools or new methods (Ottinger, 2011). In particular, the development of technology-based services must prioritize the principle of inclusivity, overcoming barriers related to access and user skill disparities (Ramle & Mardikaningsih, 2022). It requires active involvement from various parties, ranging from the government to the community that will be the direct users of the technology. Without attention to social and environmental sustainability, innovative technology can actually create deeper divides in society and damage ecosystems (Wu et al., 2016). Therefore, it is very important to analyze how technological innovations can be developed and implemented sustainably. Every technology introduced must have a positive impact, both on the environment and society, ensuring that access to that technology is open to all groups. Achieving this requires quality communication across various

organizational boundaries to build and sustain effective collaboration (Gardi et al., 2021). The discussion on the sustainability of this technology is not just about economic efficiency, but also about the moral and ethical principles underlying every innovative decision made by developers and policymakers. These ethical principles are crucial in business decision-making, as they have direct implications for corporate sustainability and relationships with external stakeholders (Mardikaningsih & Darmawan, 2022).

Developing technological innovations that consider their impact on environmental sustainability while ensuring accessibility and social justice is a complex yet crucial challenge to address in the modern era (Wang & Liu, 2020). One of the main aspects in achieving this goal is aligning new technology with sustainability principles, which not only includes reducing environmental impact but also ensuring that the technology is accessible to all layers of society (Williams, 2011). In the digital age, the challenge is even more complex as social perception and individual self-identity are increasingly shaped through interactions in the digital world (Darmawan & de Jesus Isaac, 2022). Considering that some groups may not have equal access to advanced technology, it is important to design policies that prioritize equitable access and provide equal opportunities to all members of society (Zinchenko & Filenko, 2020). Sustainability policies must be able to accommodate ongoing social changes to remain just and relevant (Halizah & Mardikaningsih, 2022).

Technological innovations, such as the use of renewable energy and environmentally friendly transportation systems, can bring significant benefits for sustainability, but often face disparities in terms of implementation and access. Many developing countries and impoverished communities may not have sufficient infrastructure to support the implementation of green technology (Li et al, 2020). Effectively communicating the value of this technology is key, and can be strengthened through sustainability communication strategies such as green marketing, which builds consumer awareness and corporate integrity (Essa & Mardikaningsih, 2021). Therefore, public policies that focus on technology that is affordable and widely accepted across various layers of society are essential. Technology that is too expensive or difficult to access can exacerbate social inequality, so policies must be carefully designed to avoid such negative effects (Greene, 2021).

One way to ensure that technology can be applied sustainably is by incorporating design principles that consider social and environmental factors in its development process (Rosen & Kishawy, 2012). Technology design that considers sustainability can include higher resource efficiency, reduction of greenhouse gas emissions, and the use of environmentally friendly materials (Zinchenko & Filenko, 2020). Oystering competence in sustainability through education and adaptive global citizenship is a foundational step to ensure that future generations are ready to contribute to these solutions (Mardikaningsih et al., 2021). In addition, technology development must also involve various stakeholders, including the communities that will be affected, to ensure that the needs and challenges faced by different societal groups can be accommodated in the developed technological solutions.

Furthermore, it is important for policymakers and technology developers to pay attention to regulations that promote transparency and accountability in the implementation of new technologies (Saner et al., 2020). Policies that ensure technological innovations are implemented fairly can help build trust among the community and minimize social inequalities. For example, policies that ensure local community involvement at every stage of innovation and technology implementation can create a sense of ownership and strengthen the effectiveness of technology use. This can also help ensure that technology not only benefits certain parties but also provides widespread advantages to all layers of society (Nasrabadi et al., 2021). Because it combines innovative strategies for environmental conservation with a strong commitment to social and economic sustainability (Nuraini et al., 2022).

In addition, in creating technology solutions that are environmentally friendly, it is important to pay attention to the principles of circular economy that can maximize resource use and reduce waste (Fogarassy & Finger, 2020). Technologies that support the circular economy, such as recycling processes or waste management, not only contribute to environmental sustainability, but waste management, not only contribute to environmental sustainability, but can also open up economic opportunities for communities (Prasetyo, 2017). Can also open up economic opportunities for communities (Li et al., 2020). This approach can provide the dual benefits of improving sustainability while creating equal employment opportunities for all community groups, regardless of social regardless of their socio-economic background (D'Adamo et al., 2022).

One of the major challenges in ensuring social justice in the application of technology is recognizing the specific needs of various communities (Leach & Scoones, 2010). Each region or social group may face different challenges related to access to technology and its environmental impact (Wang & Liu, 2020). Therefore, it is important to develop technology solutions that are local and contextual, and to involve various stakeholders in the development and implementation process. Inclusive decision-making, which takes into account the perspectives of diverse social groups, is crucial for creating technological innovations that are relevant and acceptable to society (Visvizi et al., 2018).

Social sustainability also depends on the creation of policies that support the development of local capacities to independently manage and utilize technology (Ochara & Mawela, 2015). This means that empowering local communities in technology management is very important, both in terms of technical skills training and in creating business models that support socio-economic resilience. Training programs focused on green technology skills can help prepare communities to face the changes brought by technological innovations (Novo-Corti et al., 2019).

Community based approaches in technology implementation can also serve as a monitoring mechanism to ensure that the benefits of the technology are distributed equitably (El Arifeen et al., 2013). Communities involved in the technology development process have the opportunity to provide feedback on the social and environmental impacts they experience (Zinchenko & Filenko, 2020). Thus, technological innovations that are more responsive to local needs can emerge, and the applied technology can be more aligned with the socio-economic characteristics of the region (Golova & Sukhovey, 2015).

Equally important is the education and awareness of the community regarding sustainability and green technology (Jasmi et al., 2019). To ensure broader acceptance and adoption of environmentally friendly technology, society needs to understand its benefits and impacts on their lives (Rahman, 2020). Educational programs that introduce concepts of sustainability and technological innovation to the younger generation will be the first step in building an inclusive and sustainable culture of innovation in the future (Li et al., 2020).

To support sustainability, the use of technology must also consider its impact on natural resources, including water, soil, and energy (Fernández et al., 2019). Technology that can reduce dependence on limited or non-renewable natural resources will become more relevant in the future (Wang & Liu, 2020). Therefore, it is important to develop technologies that not only reduce waste and pollution but also can restore ecosystems that have been damaged due to human activities.

Moreover, the implementation of sustainability-supporting technology also needs to be accompanied by strict monitoring and evaluation of its impact. Effective monitoring mechanisms will ensure that the technology implemented truly benefits environmental sustainability and does not create new problems in the future (Tomlinson, 2012). Governments and international organizations must work together to ensure that technological innovations continue to adapt to evolving sustainability needs (Obenaus-Emler et al., 2021).

In conclusion, although technological innovation can play a crucial role in supporting environmental and social sustainability, its implementation must be carried out with an inclusive, fair, and context-based approach (Marini et al, 2022). Access to equitable technology, empowerment of local communities, and policies that support the equitable distribution of benefits are key to creating truly sustainable technological solutions (Sovacool et al., 2022). Therefore, collaboration between technology developers, the government, and the community is crucial to ensure that technology is implemented in a way that provides long-term benefits for all layers of society.

As time goes by, the challenge of creating fair and sustainable technological innovations will become increasingly complex, shaped by rapid technological change, entrenched socio-economic divides, and escalating environmental pressures (Li et al., 2020). This complexity demands a proactive and systemic approach to innovation governance, where anticipating long-term social and ecological consequences becomes as critical as achieving short-term technical breakthroughs. Navigating this landscape requires moving beyond siloed solutions to embrace interconnected strategies that address the root causes of inequality and environmental degradation simultaneously.

However, this formidable challenge can be met with a more inclusive and sustainability-oriented approach, where technology is consciously designed and deployed as a tool to reduce social inequality and protect the environment. To realize this potential, a synergistic collaboration among diverse stakeholders including technology developers, policymakers, civil society, and local

communities is non-negotiable for formulating and enforcing policies that mandate responsible innovation (Li et al., 2020). In this framework, successful innovation is redefined; it is not only evaluated by its technical merits or economic efficiency but, more importantly, by the extent of its holistic benefits to society and the planet (Zinchenko & Filenko, 2020). Therefore, the implementation of any new technology must be underpinned by wise, anticipatory, and just policies that ensure its dividends are equitably shared and its risks are collectively managed, guaranteeing that no community or ecosystem is neglected in the pursuit of progress.

CONCLUSION

From the discussion that has been presented, it is clear that the development and implementation of technological innovations must consider environmental sustainability and social justice as aspects that cannot be overlooked. Technology developed with consideration of both aspects will be able to create solutions that are more inclusive and have a positive impact on society and the planet. Sustainability is not just about economic efficiency or technical advancement, but also about the social and moral responsibility shouldered by developers and policymakers. By ensuring that technology is not only created for certain groups but is accessible to the entire society without excluding the most vulnerable groups, technology can become a tool to reduce inequality and enhance collective well-being.

For that reason, strategic steps need to be taken to design policies that can encourage the sustainable and fair use of technology. There needs to be close collaboration among various stakeholders, including the government, society, and the private sector, to ensure that every technological innovation not only prioritizes profit or efficiency but also considers its impact on the environment and the distribution of benefits. Responsible technology can be the key to addressing various global issues such as climate change, social inequality, and poverty, as long as it is developed with the aim of creating a more sustainable and equitable world for all.

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