



Bridging Green Innovation and Real World Implementation in Nepal for a Sustainable and Inclusive Future

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Abstract

Green innovation is vital for tackling climate change and promoting sustainable development, especially in least developed countries like Nepal, which faces unique socioeconomic and environmental hurdles. Despite commitments under the Nationally Determined Contributions, there is a significant gap between the development and practical implementation of green innovations. This study analyses the factors contributing to this gap and proposes a green growth framework that balances economic, social, and environmental priorities. Employing qualitative methods, the research involved content analysis of semi-structured interviews with six experts during the OCEM Second International Conference on Green Technologies and Sustainability for a Sustainable Future.

Key findings indicate that the practical application of green innovations is hindered by weak policy enforcement, limited institutional coordination, inadequate financial incentives, and poor linkages among research institutions, educational systems, and industry. Although there is growing awareness of environmental sustainability and increased individual adoption of green practices, systemic barriers such as outdated curricula, lack of technical standards, and insufficient knowledge dissemination impede large-scale implementation. The study also highlights the underutilisation of indigenous knowledge and locally adapted, low-cost solutions as missed opportunities to bolster resilience and sustainability, particularly in rural areas.

The findings, informed by political ecology and socio-technical transition theory, suggest that the main challenges stem from structural and governance-related issues rather than technological shortcomings. The study concludes that fostering green growth in Nepal requires integrated policy frameworks, enhanced institutional capacity, inclusive governance, and collaboration among academia, industry, communities, and policymakers to bridge the gap between innovation and practice, thereby supporting equitable and context-sensitive development.

Keywords: *green growth, green innovation, institutional barriers, Nepal, socio-technical transition, sustainable development, technology adoption*

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Introduction

In Least Developed Countries (LDCs), development issues are more important in political discussions. However, almost all LDCs must adhere to the Paris Climate Agreement and Submit Nationally Determined Contributions (NDCs).

Despite the necessity of implementing of NDCs and prioritising socioeconomic development, there is a lack of studies examining the relationship between NDCs and socioeconomic development (Altieri et al., 2016; von Stechow et al., 2016). Current research on NDCs aims to foster dialogue regarding their relationship with socioeconomic development; however, there is a lack of appropriate methodologies to assess this relationship, especially in low-income countries and within the framework of government policy, which limits the ability to implement and evaluate NDCs in those contexts effectively.

This study used the notion of green growth as a strategic framework to evaluate the relationship between NDCs and critical sectors of the economy in Nepal (The case study country). Green growth is a way to promote economic growth and development while ensuring that people can access resources and environmental services from natural capital (Mensah et al, 2019). Hallegatte et al. (2012) highlighted that green growth embodies resource-efficient, clean, and resilient development. The idea of clean and resource-efficient growth implies that using fewer, cleaner, and more renewable resources could make carbon and energy more productive.

Resilient growth is when the economy expands despite climate change threatening it. This article highlights that the green growth approach has the potential to enhance coherence among policies across various economic sectors in the implementation of climate mitigation actions as NDCs. This conclusion holds because mainstream economists and policymakers favour green growth as a means of addressing climate change. They view it as a method to resolve the tension between economic development and environmental conservation (Antal & van den Bergh, 2016), which is particularly crucial for LDCs that face significant development challenges while also

needing to comply with international climate agreements (De Siqueira, 2012; Desai, 2021).

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Literature Review

This study explores green growth as a strategic framework for evaluating the relationship between NDCs and key economic sectors in Nepal, categorised as a LDC. Green growth aims to foster economic development while ensuring sustainable access to resources and environmental services (Hickel & Kallis, 2020; Taşkın, Vardar & Okan, 2020). Hallegatte et al. (2012) and Ministry of Population and Environment (MoPE), Government of Nepal (2015) emphasise resource efficiency, cleaner production methods, and resilience against climate change impacts. The study by Chalise et al. (2017), Devkota and Gyawali (2015), and IDS-Nepal (2014) highlights that adopting a green growth approach can enhance policy coherence across sectors in implementing climate mitigation actions outlined in NDCs, as endorsed by both mainstream economists and policymakers.

Nepal was selected as a case study arises from three main reasons: its status as an LDC with limited climate policy integration, its commitment to achieving net-zero emissions, and the need for socioeconomic development beyond climate-related initiatives. The introduction of NDCs by the United Nations Framework Convention on

Climate Change (UNFCCC) after 2020 highlights a structured plan for addressing climate change. However, it emphasises that LDCs risk conforming to business-as-usual practices without sufficient incentives for climate action (Antal & van den Bergh, 2016; World Bank, 2019).

Saito (2013) examined the relationship between climate change mitigation and economic/social issues, which is crucial for Nepal because adaptation tends to exceed mitigation efforts. According to MoPE (2015), addressing economic dimensions within climate policy discourse is vital. Nepal's contribution to global greenhouse gas emissions is minimal, at 0.027%, Nepal's contribution to global greenhouse gas emissions remains minimal, accounting for only 0.027% of the global total, with the Agriculture, Forestry, and Other Land Use (AFOLU) sector constituting the largest contributor to national emissions (Baniya et al., 2021; Baniya, Giurco, & Kelly, 2021).

The studies by Ferguson (2015), Saito (2013), and Santarius (2012) examined historical analyses indicating significant economic losses, with climate change impacts potentially leading to a 1.5% to 2% annual drop in GDP, escalating to 5% under severe conditions. Therefore, effective implementation of agreed NDC actions is essential to minimise future economic consequences and promote green growth through more environmentally friendly economic strategies.

This study aims to examine how combining resource utilisation and Greenhouse Gas (GHG) emissions with the green growth framework can ensure the effective execution of Nepal's NDCs, advocating for a balance with other related policies.

Green technology has transitioned from a voluntary initiative to a critical necessity due to global demands for sustainability. As industrialised and developing nations cope with climate change, environmental degradation, and resource scarcity, countries like Nepal, particularly vulnerable to climate impacts, exemplify the urgent need for sustainable solutions. This article discusses how green innovation can enhance social well-being, economic stability, and resilience, despite the gap between theoretical innovation and its practical implementation. This emphasises the

systemic strategy needed to bridge this gap by incorporating modern technologies, local practices, and supportive institutional frameworks (United Nations Environment Program [UNEP], 2021; Intergovernmental Panel on Climate Change [IPCC], 2022).

This research evaluates the obstacles to translating green innovation into actionable solutions in Nepal, focusing on institutional, economic, and sociocultural barriers, as well as the need for low-cost, locally adapted green technologies to address rural challenges such as climate resilience and water conservation, which critiques public procurement processes, legal frameworks, and government policies for their roles in fostering or hindering innovation (Dhar, 2021). The importance of higher education institutions in knowledge creation, skill development, and technology transfer is also underscored, alongside the imperative of inclusive green growth to prevent the complication socioeconomic disparities (World Bank, 2019; Asian Development Bank [ADB], 2021).

Despite progress in community resource management and renewable energy (notably hydropower), the adoption of green technologies in Nepal remains sporadic due to poor institutional coordination, insufficient funding, inconsistent policies, and limited stakeholder engagement. Furthermore, traditional knowledge systems often clash with modern engineering practices, leading to the undervaluation of indigenous construction techniques that utilise sustainable materials. Public doubt about green technologies' reliability and financial viability further stifles private-sector participation and innovation (Janjic, 2025; United Nations Development Programme [UNDP], 2021; World Bank, 2019).

This study uses Roger's Diffusion of Innovations Theory as a framework to analyse the above mentioned challenges, highlighting key adoption factors such as compatibility and observability. Many green technologies face issues of acceptance in Nepal, and the theory suggests that building trust, enhancing institutions, effective communication, and associating innovations with local needs are essential for successful implementation (Rogers, 2003; Greenhalgh et al., 2004).

Methods and Materials

A qualitative approach is useful for understanding human perceptions and experiences of the importance of collaboration, its challenges, and the global growth of educational institutions in Nepal. A thorough understanding of the multidisciplinary research capacity in emerging provincial universities, as well as challenges, collaboration, and global lessons, is necessary for the provincial universities and their expansion of research collaboration, which can be fulfilled by applying content analysis to extract information from semi-structured interview data (Lichtman, 2013; Cohen, Manion & Morrison, 2017).

Using a methodical coding procedure to minimise complexity and identify significant themes and patterns, content analysis is an organised method for organising, analysing, and interpreting a large amounts of textual and visual data (Hsieh & Shannon, 2005; Patton, 2002). A purely quantitative approach is insufficient to capture the nuanced perceptions of panelists regarding green innovation and its real-world implementation in Nepal, which often overlook context-specific insights, lived experiences, and the complex socio-economic and cultural factors that influence sustainable practices. Therefore, this study adopts a qualitative approach, which allows for an in-depth exploration of participants' perspectives, enabling a richer and more comprehensive understanding of how green innovation can contribute to a sustainable and inclusive future in Nepal. (Creswell & Plano Clark, 2018). The panelists were from Madhesh University, Birgunj; Wittenberg University of Applied Sciences, the Netherlands; Akami University, America; Madan Bhandari University, Nepal; Pokhara University; and Nepal Electricity Authority (NEA) Hydropower, Nepal. Data from semi-structured interviews were collected from six experienced and high-potential scholars and academicians at the second OCEM international conference, entitled Innovations for a Sustainable Future: Advancing Green Technologies and Multidisciplinary Research. The interviewees were purposively selected because not all academicians were identified as having holistic knowledge of the conference themes (Adhikari,

2022; Adhikari et al., 2026). This content analysis is based on the study of Adhikari (2022, p. 124), who followed an inductive approach of five steps of content analysis, where the first step is to transcribe recorded electronic data into Word texts; secondly, to identify the key codes based on the research questions; thirdly, to record the key keycodes separately; and fourthly, to determine subcategories of different Keycodes based on their similarities. The fourth step is to convert the subcategories into main categories. The fifth step is to interpret the main categories that associate to the different perceptions of the interviewees and support their individual statements (see Figure 1).



Figure 1: Summary of the Merged Subcategories of the First Interview

Content Analysis

The OCEM Second International Conference's inaugural panel discussion featured six interviewees, each of whom received at least three interview questions, which focused on green and sustainable development, data and observations, resilient infrastructure, environmental management, institutional support, Environmental, Social, and Governance (ESG) incentives, research, knowledge transfer, and community engagement, all of which are essential for Nepal's sustainability.

The results show six subcategories initially. After merging them by similarity, two subcategories emerged: 'Sustainable and Interdisciplinary Infrastructure and Environmental Management and Ecosystem Services'.

The first interviewee reported that physical

infrastructure, greenness and sustainability, and interdisciplinary approaches, rather than individual fields, are essential in planning, with environmental impacts and climate change becoming increasingly important. He further highlighted the importance of campus and interdisciplinary collaboration (see Figure 2).

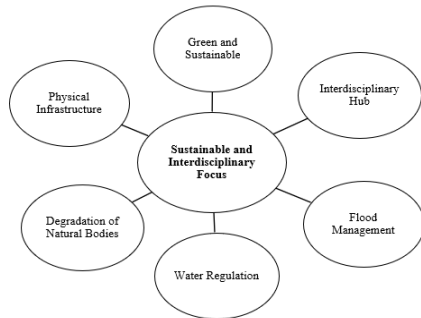


Figure 2. Focus on Green Technology

He stated:

“In my experience, or what we experienced around the 1990s, development involved building physical infrastructure, and civil engineering was viewed as being standalone. In recent years, there has been a shift in focus to green technology and the environment. There is evidence and information available on climate change, and all acknowledge that it is real and significant. Incorporating environmental flows and climate change in development has become mandatory.”

The same interviewee further disclosed that degradation of natural bodies, water regulation, storage functions, and flood management are issues. He focused on the protection and restoration of ecosystems, the maintenance of water resources, and the mitigation of natural hazards.

He stated:

“Most of the natural ponds have vanished; yet they serve vital purposes in water storage and flood mitigation. Interference with natural flows has led to infrastructure collapse. Adoption of sound policies that ensure the natural flow of water and the conservation of ponds and lakes in rural settings would help reduce flood incidents and improve groundwater recharge.”

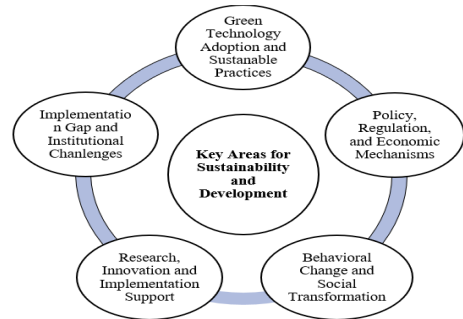


Figure 3: Summary of the Merged Subcategories of the Second Interview

Initially, several subcategories were identified that could be associated with green technology adoption, policies, research implementation, and institutional barriers. Based on their similarities, they were combined into five broad categories: “green technology adoption and sustainable practice; policies, regulations, and economic instruments; behaviour and social change; research; innovation and implementation facilitation; and implementation gaps and institutional barriers” (see Figure 3).

The second interviewee reported that although green technology has become essential and compulsory, Nepal is still largely driven by a reactive approach rather than a proactive one. He emphasised that individuals have begun adopting green practices, such as solar panels and electric vehicles, but there is a lack of institutional support, including policies, subsidies, and grants. He further highlighted the adoption and integration of environmentally friendly technologies in development and research.

He stated:

“Green technology is mandatory, yet in Nepal, we practice our policies reactively. On a personal basis, there is the use of solar energy and electric vehicles. However, there is nothing like grants or policy incentives at an institutional level, which hinders the widespread adoption of green technologies and discourages organisations from investing in sustainable practices. Without a regulatory authority to enforce policies, no one adopts them. There should be a pulling factor towards implementation.”

Policy and economic approaches were another factor highlighted by the interviewee; which included ESG frameworks, tax policies, and penalties for unsustainable behaviour. The role of business was emphasised because businesspeople can influence society and help make it more sustainable. In addition, it was noted that changes in behaviour at the individual and organisational levels are crucial. In his opinion, changes in the behaviour of both individuals and organisations are very important too.

He stated:

“When ESG systems are implemented, there is going to be a contest to save energy. There could be tax cuts or awards that would encourage corporations to save energy. “Behaviour is significant since simple behaviours, such as stopping vehicles at traffic lights, may contribute to energy savings if regulated well.”

Furthermore, the interviewee emphasised the importance of conducting sophisticated research and performing a life-cycle cost analysis to demonstrate the efficacy of green technology. He cited cases such as dry toilets, wooden pipes, and bio-engineering alternatives that could prove more efficient than traditional approaches. He further emphasised an important limitation in communication between research and practice, in which research results remain unavailable to practitioners due to costs and ignorance.

He stated:

“Life cycle costing is needed to persuade others. Dry toilets or wooden pipelines could be the best way to go, but there is no research on that. In addition, there is no such agency that would make researchers’ work available to society, which hinders the practical application of research findings beyond academic circles. Research serves well in academics, but nothing else.”

In addition, he elaborated on issues related to university structures, such as outdated curricula, bureaucracy, and instructors’ inflexibility. The interviewee highlighted that unless curriculum reforms take place, an accreditation system is implemented, and green standards are included in professional codes, it is impossible to make

green technologies mainstream in education and practice.

He stated:

“There exists a big difference between theory, practice, and policy. Universities struggle to update the curriculum promptly, viewing green technology as a nascent issue. The lack of codes and professional standards means that it cannot be applied.”

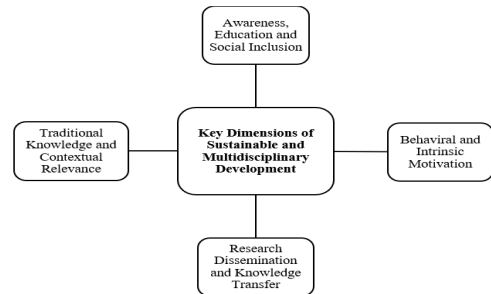


Figure 4: Summary of the Merged Subcategories of the Third Interview

The results show seven subcategories initially. After merging them by similarity, four subcategories emerged: “traditional knowledge and contextual relevance, research dissemination and knowledge transfer, awareness, education and social inclusion, and behavioural and intrinsic motivation for sustainability”.

The third interviewee said Nepal and Europe learn from each other. The interviewee provides an example of how European countries like Norway are applying knowledge of traditional engineering practices in Nepal to create sustainable environments.

She stated:

“Norway hires many Nepali train-makers to help build tracks using local, traditional engineering knowledge. This helps preserve nature rather than relying solely on modern technology, as traditional engineering knowledge often incorporates sustainable practices that are more in harmony with the environment. This demonstrates our ability to learn from both external and internal sources, integrating traditional and modern practices.”

Additionally, the interview explained that research

tends to be limited to academic settings and fails to reach the general public, which hinders the dissemination of valuable knowledge and innovations that could benefit environmental sustainability. As a result, it does not fall into the government's hands, which could fund green inventions, leading to missed opportunities for innovation and sustainable development in the community. Additionally, a cycle should be established in which research contributes to societal development, and society, in turn, supports further research.

She stated:

"Research must be communicated, or else it will remain in the universities. Unless the citizens know about it, the government won't support green technology. With more awareness, research will produce more funds for society."

Moreover, she mentioned that another key aspect of success is being aware, educated, and inclusive, for example, through programmes such as GREEN4edu that educate not only students but also grown-ups and the wider society. The point here is that green technology needs to have social significance. People need to feel involved and included; they will not be able to identify with the development of new technologies.

She stated:

"If individuals have heard about green technology but do not fully understand its meaning, they will feel excluded. This will mean that they need to be included in all dialogues concerning green technology so that they feel part of society."

In psychological and social contexts, the interviewee emphasised that awareness drives behaviour change. It is because when people become aware of the concept of sustainability and begin making associations, their intrinsic motivation and feelings of responsibility towards the environment develop.

She stated:

"People will not feel the need for green concepts if they lack a connection to them." By involving them in education and workshops, we can raise awareness that leads to inner motivation and well-being."

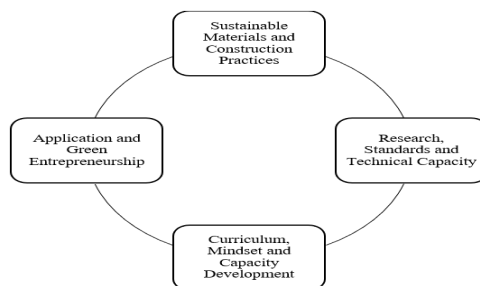


Figure 5: Summary of the Merged Subcategories of the Fourth Interview

He stated:

"We have a mindset that buildings must be made of concrete or steel to be considered resilient and safe. If you think of bamboo structures, people consider them temporary. To change this perception, we need to redesign our curriculum and start teaching how to make green buildings safer. Safety depends on design and construction, not just materials."

The results show eleven subcategories initially, after merging them by similarity, four subcategories emerged: "application and green entrepreneurship, research standards and technical capacity, curriculum, mindset and capacity development, and sustainable materials and construction practices."

As the fourth interviewee pointed out, one major problem regarding building safety in Nepal is that the general attitude toward building safety tends to be strongly biased against the use of green or natural materials due to the perception that they are not safe enough. This bias is attributed to the lack of an educational curriculum on green building materials.

The fourth interviewee said that there was an urgent need for proper research, standardisation, and experimentation. Without those three requirements, it would be impossible to adopt any material or construction technique. Validating natural materials such as bamboo is difficult, as their properties vary by species and place of origin, which complicates the standardisation process necessary for their adoption in construction techniques. Ongoing research on masonry using bioadditives.

He stated:

“The problem here is that there is no research at all. Without codes and standards, nothing can be designed. There must be experiments, numerical tools, and new materials for green buildings to succeed.”

The result show that curriculum changes, and a mindset change were also highlighted as very important issue of building materials. According to the interviewee, there is no teaching on the use of green materials in engineering schools, and thus, graduates find it difficult to use them in the real world. It is thus necessary to upgrade the curriculum and develop an innovative mindset to design resilient constructions.

He stated:

“We have to change our curriculum and start thinking about how to make safer green buildings. Education and mindset development are key to adopting sustainable construction practices.”

Lastly, the interview identified entrepreneurship and application as among the most important channels engineering students could pursue after graduating from university. Research on bamboo construction, masonry restoration, and tourism-related construction projects is already generating innovations and environmentally friendly businesses.

He stated:

“Students can develop entrepreneurial skills by working in bamboo architecture or by transforming brick buildings into tourist attractions. We seek to imbue entrepreneurship thinking and advise students on future ventures in sustainability.”

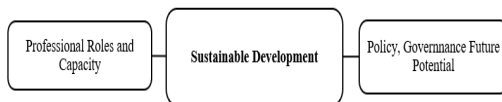


Figure 6: Summary of the Merged Subcategories of the Fifth Interview

The results show seven subcategories initially. After merging them based on their similarity, two subcategories emerged: “professional roles and capacity” and “policy, governance, and future potential”.

The fifth interviewee emphasised the key role of engineers in the adoption of green technology in Nepal and the advantages and disadvantages of implementing it. Engineers were stated to be at the forefront of the application of green technology.

A large gap was found between theoretical understanding and practical application, where he highlights the necessity of policies, skill development, and innovations through research. The engineer should adapt to the local community environment, as technology that works in one community (such as the Himalayas) may not work in another location (such as the Terai).

He stated:

“Engineering designers play a significant role in implementing green technology. There is indeed a significant difference between theory and practice, but in policy, the future of green technology looks promising.”

He highlighted that in terms of green technology and renewable energy. He further pointed out that Nepal has ample natural resources to exploit, particularly for hydropower projects. In addition, Nepal has very good laws and policies. But the main problem lies in the lack of implementation of these laws due to limited awareness and inadequate monitoring.

He stated:

“Nepal has very high potential for green technology. Policies exist, but we need better implementation and awareness. Engineers must consider the local context to apply technology effectively.”

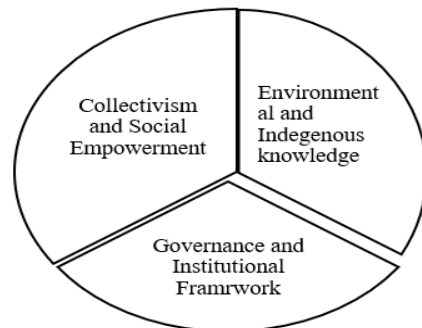


Figure 7: Summary of the Merged Subcategories of the Sixth Interview

The results show six subcategories initially. After merging them based on their similarity, three subcategories emerged: “collectivism and social empowerment, environmental and indigenous knowledge, and governance and institutional framework”.

The sixth interviewee disclosed how interdisciplinary and multilevel strategies are important for achieving sustainable development in Nepal. According to him, collective action is essential for progress, since any individual perspective is insufficient. The problems that Nepal faces regarding green technologies and policies can be traced to a lack of integration and fragmentation.

He stated:

“Until we have a collective view and collective effort, we cannot move ahead. One of the major reasons behind Nepal being down is the lack of collectivism...lighting the light only in the corner cannot show the holistic picture.”

The sixth interviewee has pointed out a gap in the governance structure and the inadequacy of institutional mandates. Even if there are experts in international arenas, such as the United Nations Environment Assembly (UNEA) in Nepal, they can not be sufficiently authorised to play an effective role in shaping decisions on climate change and disaster management.

He stated:

“We change the government every time. Where is Green Tech? Where are the policies? Whenever a new minister comes, previous policies are often replaced, creating a major hurdle.”

The interviewee further reported that social empowerment, indigenous knowledge, and local governance have to be discussed. Nepal has robust theoretical foundations for incorporating marginalised populations, women, and indigenous knowledge in environmental conservation efforts. The three-tier system currently operating in Nepal enables local stakeholders’ participation in environmental decision-making processes. There have been benefits of empowering women by giving them positions of authority locally.

He stated:

“Nepal is good at incorporating poor people into policy, including indigenous and social knowledge. Women’s empowerment is super important, and municipalities with women deputy chairs have had a significant positive impact on community decision-making and resource allocation, leading to more inclusive and effective policies that benefit all citizens.”

The show that women’s empowerment can be one of the very important factors to enhance the environmental policy.

Summary of the Results

The OCEM Second International Conference conducted a panel discussion with six interviewees about green and sustainable development in Nepal. The findings highlighted the importance of interdisciplinary approaches in infrastructure and environmental management, as well as the roles of policy and community engagement. The first interviewee highlighted the necessity of integrating environmental considerations into planning and restoring ecosystems. He further emphasised the reactive nature of green technology adoption in Nepal due to insufficient institutional support and the importance of behavioural change.

The second interviewee pointed out the need for effective research dissemination and public engagement for awareness of green technology. The third interviewee highlighted biases against green materials in construction and the necessity for curriculum changes to support sustainable practices. The interviewee highlighted the engineers’ crucial role in the adoption of green technology and the gap between theoretical knowledge and practical application. The fourth interviewee underscored the need for collective action and proper governance to facilitate sustainable development in Nepal, emphasising that without those elements, initiatives may fail to achieve their intended impact and that collaboration among stakeholders is essential for success.

Overall, the discussions of six interviewees reveal a spectrum of challenges and opportunities for advancing sustainability in the Nepalese region.

Discussion, Conclusion, and Recommendations

This study's findings indicate a substantial institutional, political, and sociocultural gap between green innovation and its practical implementation in Nepal. Political ecology and socio-technical transition theory, when combined, provide a comprehensive explanation of the challenges associated with operationalising green growth in LDCs.

From a political ecology perspective, conflicting development agendas, institutional fragmentation, and power dynamics significantly influence on environmental governance in Nepal. Global frameworks like NDCs promote sustainability, but national politics, limited resources, and unequal access to decision-making power make it harder to put these ideas into practice (International Energy Agency (IEA), 2022). The panel's findings reflect what political ecology experts call the "politics of environmental governance": policies exist in theory but do not work well in practice. This is especially true when it comes to weak enforcement, policy discontinuity, and lack of institutional coordination, which each associated with Antal and van den Bergh's (2016) critique that, without systemic reforms, green growth may obscure deeper structural injustices.

Moreover, despite the demonstrated relevance of local and indigenous knowledge systems for sustainable practices, such as resilient construction and water conservation, the study underscores their marginalisation. Political ecology shows how common technocratic ideas, which favour standardised, expensive solutions over those better suited to the situation, often ignore this kind of information. This conflict is illustrated by bamboo construction and traditional water systems, where locally viable solutions are disregarded due to the absence of institutional support, formal acknowledgement, and established standards, which each corroborates with Saito's (2013) assertion that climate plans should integrate socio-economic realities rather than enforce externally imposed models.

The Multi-Level Perspective (MLP), a type

of socio-technical transition theory, can also explain the systemic resistance seen in Nepal's sustainable transition. This paradigm highlights that transitions arise from interactions among three levels: niches (innovations), regimes (dominant systems), and landscapes (macro-level forces such as climate change). Green technologies, including bioengineering solutions, renewable energy systems, and traditional practices, exist in Nepal at a niche level but struggle to increase due to resistance from entrenched regimes, such as conventional construction techniques, dependence on fossil fuels, and rigid institutional structures.

The results clearly show that Nepal's current system is characterised by a locked-in socio-technical regime, where established policies, infrastructure, and educational institutions support traditional practices that are often not sustainable. Some ways regimes fight change are by keeping old curricula, failing to adopt green standards, and giving institutions no reason to change. This supports what the Intergovernmental Panel on Climate Change (IPCC) (2022) and OECD (2020) stated that institutional change and policy alignment are just as important for transitions as new technology.

Moreover, the spread of new ideas is limited by the absence of effective "bridging mechanisms" between niches and regimes, including finance, knowledge transfer systems, and government incentives, all of which are crucial for facilitating the exchange of innovative practices and technologies across sectors. This study strongly supports Rogers' Diffusion of Innovations Theory (2003), and Ministry of Population and Environment (MoPE), which says that adoption depends on communication channels, social systems, and perceived benefits. The lack of demonstration projects and the inability to share research outside of academia are slowing the adoption of green technology in Nepal.

Another thing to remember is how important agency and behavioural change are in transition processes. Socio-technical transitions are not only about structures; they also depend on people, groups, and communities who either support or fight against change. The panel's findings show

that systemic change is difficult to achieve because institutions lack sufficient support, even as more people adopt technologies such as solar panels and electric cars, which shows a bottom-up transition dynamic that leads to uneven progress when there is not enough top-down support.

The research emphasises the value of equitable and inclusive transitions, a concept increasingly recognised in both transition theory and political ecology. Nepal theoretically commits to inclusion, but the benefits of green growth remain unevenly distributed. For example, women are not yet empowered, and communities are not yet involved. (UNDP) (2021) and Guivarch, et al. (2023) stated that this situation raises questions about whether green transitions could worsen existing inequalities or maintain them. To ensure that green growth helps marginalised communities, policymakers need to be more careful about how they make decisions and run the government.

Finally, the results highlighted governance issues, especially policy inconsistency and a lack of long-term vision, which could be considered a failure to align national-level institutional responses with landscape-level forces such as climate change and international agreements, which ultimately undermines effective environmental management and sustainable development efforts. Nepal's internal systems are still not flexible enough, which causes problems at all stages of transition, particularly in adapting to external pressures such as the Paris Agreement and in effectively implementing policies that support green growth for marginalised communities. This is despite the fact that there are many external pressures, such as the Paris Agreement, which require Nepal to adopt more sustainable practices and policies to meet international climate commitments.

Conclusion

This analysis indicates that Nepal's challenges in implementing green growth and NDCs stem from profound structural, institutional, and political constraints rather than mere technical difficulties. Using political ecology and socio-technical transition theory makes it clear that sustainability transitions require more than new ideas; they

also require changes to knowledge systems, governance, and socioeconomic institutions.

From a political ecology perspective, effective green transitions must address power imbalances, institutional flaws, and the exclusion of local knowledge, which will ensure that sustainability efforts take into account the needs of all people and the situation. Transition theory holds that Nepal needs to strengthen the relationships between creative niches and dominant regimes if green technologies are to move from being tested in small groups to being used by everyone.

The report suggests that some of the main things that need to be addressed to achieve this are making policies more consistent and enforcing them more effectively, encouraging knowledge transfer between academia and practice, restructuring education systems to build green capacities, and combining indigenous knowledge with modern innovation. To make green technology more socially acceptable, we will also need to engage people and change their behaviours. Nepal's ability to shift from a broken, reactive system to a proactive, integrated one will ultimately determine how it grows sustainable.

Recommendations

Policy and Governance: Establish regulatory bodies, maintain consistent policy direction, develop clear implementation frameworks, and improve inter-institutional coordination.

Financial and Economic Incentives: Advocate for tax incentives, support for green technologies, and create mechanisms for green financing.

Research and Transfer of Knowledge: Foster collaboration between academia and industry, support applied research, and enhance knowledge sharing.

Education and Capacity Building: Update curricula, establish technical standards, and advance interdisciplinary learning in green sectors.

Local Solutions and Indigenous Knowledge: Integrate traditional practices into policies, promote sustainable technologies suited for local conditions, and research traditional methods.

Institutional Capacity Building: Strengthen



local and national authorities, improve governance structures, and enhance accountability.

Awareness and Behavioural Shifts: Implement public awareness campaigns, support environmental education, and provide incentives for sustainable behavior.

Innovative Entrepreneurship: Encourage the establishment of green startups and innovation hubs and promote public-private partnerships.

Implementation and Demo: Develop pilot projects for green technologies and conduct life-cycle cost analyses.

Diversity and Inclusion: Ensure marginalised communities and women participate in decision-making processes related to green growth.

Long-Term Plan: Align development policies with climate commitments and create a national roadmap for green growth.

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