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Attitudinal aspects of Consultants, Builders, Local People and Other Stakeholders towards Sustainable Infrastructure Development

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Abstract

Sustainable infrastructure development is critical in today's world, balancing the need for progress with the preservation of natural resources. However, the success of such initiatives largely depends on the attitudes and perceptions of key stakeholders, including consultants, builders, local communities, and government entities. This article explores these attitudinal aspects, highlighting challenges, opportunities, and strategies to align stakeholders' perspectives with sustainable practices. The pursuit of sustainable infrastructure development has gained significant importance in Nepal, driven by increasing environmental challenges, rapid urbanization, and the need for resilient, eco-friendly systems. This study explores the attitudinal aspects of key stakeholders consultants, builders, local communities, and other entities towards sustainable infrastructure development.

Consultants, as designers and planners, demonstrate a growing awareness of sustainable practices, but their efforts are often constrained by resource limitations, inadequate policy

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enforcement, and a lack of advanced technical training. Builders and contractors are primarily concerned with cost and time efficiency, which can lead to resistance against adopting sustainable materials and practices unless incentivized. Local communities, despite having intrinsic knowledge of their environments and a vested interest in long-term benefits, often face limited inclusion in planning processes and lack awareness about sustainable construction's broader impact. Meanwhile, environmental organizations, government bodies, and international donors show strong advocacy for sustainability but are hampered by fragmented coordination, inconsistent policy implementation, and resource constraints.

This study highlights the importance of aligning stakeholders' attitudes and actions to achieve sustainable outcomes. It emphasizes the need for capacity building, inclusive planning, financial incentives, and stricter enforcement of sustainability policies. Addressing these attitudinal and systemic gaps can foster a collaborative environment for sustainable infrastructure development, benefiting both the environment and society at large.

Keywords: adopting sustainability, collaborative environment, inconsistent policy, urbanization

1. Introduction

Sustainable development and construction is the responsibility not only of researchers. It requires concerted action by all stakeholders involved in the creation and use of the built environment. Clients need to demand a more sustainable built environment, professionals need to adopt and promote sustainable construction practices through their work, the construction industry needs to commit to following sustainable construction processes, and regulatory bodies need to encourage, enable and enforce sustainable construction. If all these stakeholders are to fulfill their roles, the educational sector has to provide them with the necessary training and with educators who themselves are committed to sustainability. These educators will need the knowledge that is being developed by the researchers as part of the proposed R & D agenda. For the researchers to develop this new knowledge, they will need the participation and support of clients, contractors, professionals, governments and regulators (UNEP-IETC, 2002). Therefore, sustainable construction can happen only if all the necessary elements – both technological and contextual enablers, as well as stakeholders – are developed and work together at local, national, regional and international levels.

The universally accepted set of theory of sustainable development is named the *Triple Bottom Line* is the theoretical framework used in this research, which includes three broad components: social, environmental and economic aspects of sustainability (Figure 1). This international set of sustainability metrics is often used to gauge the success of a particular development project (Roger, Jalal, & Boyd, 2006). It is treated as a basic start-point for sustainability initiatives where scholars and researchers of various disciplines engage in, and formulate, the sustainability principles concept for their respective area of development interests.

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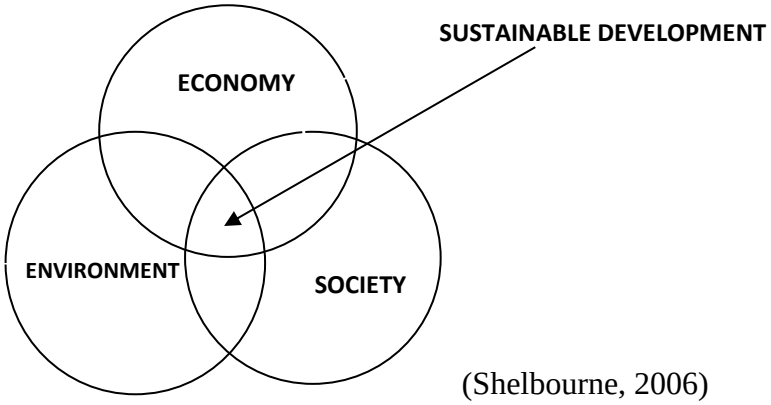

Sources: (Shelbourne, 2006)

Figure 1: Themes of Sustainable Development

Development of infrastructure in rural areas requires a multidisciplinary approach which considered social, gender equity issues, economic and financial, engineering and technology, environmental and bio-technical factors for the sustainable economic development (Abdul H., Ahmad H., 2009).The sustainable approach is the one which move a step forward beyond developing only basic infrastructure. It is essential to adopt the appropriate technology based on the need of people and stage of development. The term "sustainable" can be defined as "avoiding depletion of natural resources". The very act of building a bridge uses natural resources but is done so with the objective of providing a transport solution that gives enduring benefits to society that also help the cause of conserving the planet's natural resources.

For the context of the built environment discipline, sustainable construction is seen as a way for the building industry to respond to achieve sustainable development (Bourdeau, 1999). Principally, sustainable construction can be defined as a construction process which incorporates the basic themes of sustainable development (Sage A. P., 1998; Chaharbaghi & Willis, 1999; Parkin, 2000). In other words, a construction project is sustainable when it responds to the conventional environmental challenges of resources depletion, addresses social and cultural needs and practices, as well as generates economic empowerment or alleviates poverty.

In an attempt to integrate sustainability into construction industry, Hill and Bowen(1997) have developed the concepts of sustainable construction that are divided into four 'pillars' of sustainability – social, economic, biophysical and technical – with a set of overarching, process-oriented principles. Although the proposed concept of sustainability principles provides a good understanding of sustainable construction, for the most part, it is too general to elicit application at project level. This is a challenge still to be met. Hill and Bowen do advise, however, that the choice of which principles to apply to a particular construction project, and the decision on the extent to which each chosen principle should be applied, reflect value judgments; i.e. whether to apply weak, strong or very strong sustainability. They further contend that it is best if these judgments are made by the interested and affected parties involved in a project. The emphasis, therefore, should be on implementing a process which

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seeks to achieve consensus among interested parties on which principles are more, and which are less, important.

Given the pressing need of our mother earth, the growing maturity of mankind towards a shared future, and an increased awareness by governments of different nations, sustainability development initiatives will continue for the long-haul. It is a journey rather than a destination for mankind, and an organic process that naturally invites all parties to its noble fold. However, until each individual, local, national and international community responds earnestly to these initiatives, the potential results, as promised by sustainable development, will remain unrealized.

Integrating sustainability into various disciplines and practices has received considerable attention in recent years. A review of the literature, however, shows that very few studies have targeted construction project management. This presents a major problem, given that as announced By (International Energy Agency, 2018); the construction industry is responsible for about 41% of total energy consumption globally, and close to 40% of total CO_2 emissions. Despite these facts, integration of sustainability into construction project management practices has been very slow, with outcomes being far from satisfactory (Marcelino-Sádaba, S., González-Jaen, L. F. and Pérez-Ezcurdia, A., 2015). This reflects the impacts of barriers, as a result of which, attempts towards making construction project management practices sustainable have been thwarted.

Contrary to popular belief, sustainable development is not merely development that can be sustained, but rather the kind of development we need to pursue in order to achieve the state of sustainability. It is not the goal, but the process of maintaining a dynamic balance between the demands of people for equity, prosperity and quality of life and what is ecologically possible. (IIED, 2001) Development is also not just seen in its narrow meaning of growth, expansion and acquiring of knowledge, but as progress through improvement, evolution and the quest for wisdom. While the scope of the term is still evolving as it is co-opted by more and more disciplines and advocacy groups, it is generally agreed to place certain demands on human activity in the three systems central to development. The economic aspects of sustainable development require the development of an economic system that facilitates equitable access to resources and opportunities and the fair sharing of finite ecologically productive space, which enables sustainable livelihoods, and establishes viable businesses and industries based on sound ethical principles. The focus is on creating prosperity for all, not just profits for a few, and to do this within the bounds of the ecologically possible and without infringing on basic human rights.

The social aspects of sustainable development require that we enable the development of fair and just societies that foster positive human development and provide people with opportunities for self-actualization and an acceptable quality of life. The environmental aspects of sustainable development require that we find a balance between protecting the physical environment and its resources, and using these resources in a way that will allow the earth to continue supporting an acceptable quality of life for human beings (UNEP, 1999). It is highly

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unlikely that all of the sustainability principles implicit in the above statements can be upheld at all times, as they have conflicting requirements. Most of the time, decision-makers will have to make trade-offs and otherwise try to balance the different requirements to find a solution that is the optimum one for the greater good. These decisions need to be flexible and should be regularly reviewed against agreed-upon indicators to keep the three systems in dynamic balance and ensure that the one sphere is not developed at the expense of the others.

Sustainable construction is seen to imply holistic thinking as regards construction and management of the built environment, taking a lifecycle perspective. It implies not only new environmentally orientated construction designs, but also new environmentally friendly operation and maintenance procedures. Not only must construction materials and components be produced in a sustainable way, but their use must also answer to new requirements deriving from holistic environmental prerequisites (ILO, 2001). For example, there is no sense in producing cladding glass in an environmentally friendly way, if that sheet of glass is going to be used as a façade or roof in a Brazilian tropical climate.

However, just as the concept of environmental sustainability is still unfolding as our knowledge about the environment expands, so is the understanding of sustainable construction as a concept that extends beyond the biophysical impact of the built environment (CICA/UNEP, 2002). Thus, the concept of sustainable construction now transcends sustainability to embrace economic and social sustainability, which emphasizes possible value addition to the quality of life of individuals and communities.

For many years there has been a tendency for sustainability studies in construction to give greater emphasis to the dimensions or aspects denominated as technical, i.e. ecological and geographical/spatial sustainability as described by (Sachs, 1997). As a result, this approach has often ended up neglecting the social contradictions making the environmental issue mainly and in some cases exclusively a technical one. Thus, understanding of the non-technical aspects (i.e. social, economic and cultural sustainability), as well as the political, must be encouraged and practiced in countries which have to fight against social exclusion as one of their priorities. This change of focus, or increased plurality of approach, should contribute towards helping developing countries to face up in a more productive way to the challenges presented by sustainable development within their reality, given that the social, economic and cultural contradictions are the true causes of their environmental problems (Falloux and Talbot 1993; Malan, J.S. 1988).

2. Stakeholder Perspectives

Sustainable infrastructure development involves diverse stakeholders working together to ensure projects are environmentally friendly, socially inclusive, and economically viable. Key players include governments for policy and regulation, private sectors for investment and construction, and development agencies for funding and technical support. NGOs and local communities ensure social equity and environmental protection, while academia and research institutions contribute innovative solutions. Technology providers and regulators maintain

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quality and sustainability standards, and the media shapes public awareness. Each stakeholder plays a unique role in achieving long-term, resilient infrastructure development (WEF, 2024). In this new global economy, stakeholder engagement is increasingly becoming a part of construction project practice in order to deliver excellent project outcomes. For example stakeholder identification is a critical component of the initial scoping phase and should occur before an engagement plan is formulated and consultations begin. As each stakeholder usually has their own interest in the project which may cause different priorities, conflicts and dramatically increase the complexity of the situation (Karlsen, J.T.; Græe, K.; Massaoud, M.J., 2008). A well-managed stakeholder engagement process helps the project stakeholder to work together to increase comfort and quality of life, while decreasing negative environmental impacts and increasing the economic sustainability of the project. Stakeholder engagement should therefore be taken as a core element of any "sustainable development" plan. Hence a project is more likely to be successful, especially in the long-term, if it takes into consideration the expectations of the stakeholders and endeavors to meet their needs.

2.1 Consultants and Planners

Planning consultants have a big role in the realization of Sustainable Construction because the implementation of Sustainable Construction not only requires an understanding of how project construction management should be carried out but also thinks about how the project planning process accommodates environmentally friendly principles must be carried out. Such development methods are known by various terms such as sustainable development, eco-design, eco-friendly architecture, environmental architecture; natural architecture. The consultants and planners should follow the Agenda 21 for sustainable construction which was published by the International Council for Research and Innovation in Building and Construction (CIB) in 1999. According to the main principles of sustainable construction has to follow:

- Maximization of resource reuse;
- Minimization of resource consumption;
- Use of renewable and recyclable resources;
- Protection of the natural environment;
- Creation of a healthy and non-toxic environment; and
- Creation of quality in built environments.

Sustainable construction embraces three main dimensions namely social, economic and environmental in contrast with the traditional perspective, where the main concerns were economy, utility, and durability. The social dimension addresses issues pertaining to the enhancement of people's quality of life. The economic dimension addresses economics issues such as employment creation, competitiveness enhancement, lower operating/maintenance costs, employment creation, high quality of working environment leading to greater productivity and many others (Baloi, 2003). The environmental dimension deals with the design, construction, operation/maintenance and deconstruction approaches that minimize the

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adverse impacts on the environment such as air emissions, waste discharges, use of water resources, land use, and others.

In Nepal, the role of consultants and planners in advancing sustainable construction practices is pivotal, especially in the road sector and critical infrastructure like housing, schools, and public buildings. Their contributions span technical innovation, policy formulation, and capacity building, addressing Nepal's unique challenges of fragile terrain, climate vulnerability, and socio-economic disparities.

a. Roads: Climate-Resilient and Environmentally Friendly Designs

Consultants and planners play a crucial role in designing and implementing climate-resilient road infrastructure. Given Nepal's vulnerability to landslides, soil erosion, and flooding, sustainable practices such as bioengineering techniques (e.g., vegetation for slope stabilization) and effective drainage systems are essential (Shrestha, 2010). The integration of locally available materials and low-carbon construction techniques, such as cold-mix asphalt, further reduces environmental impacts and construction costs (ICIMOD, 2001).

Programs like the Green Roads in Nepal (GRiN) emphasize the importance of eco-friendly approaches to rural road construction, which mitigate environmental damage and promote long-term resilience (ICIMOD, 2001). Similarly, the Rural Access Programme (RAP) highlights the value of community participation and capacity building in sustainable road development, ensuring that infrastructure remains functional and locally maintained (DFID, 2019).

b. Other Critical Infrastructure: Resilient and Inclusive Development

Beyond roads, planners and consultants are instrumental in designing disaster-resilient buildings, such as schools and hospitals, which are crucial for Nepal's earthquake-prone regions. They advocate for the adoption of Nepal's National Building Code (NBC), which includes earthquake-resistant construction standards and promotes green building practices (DUDBC, 2015). The use of sustainable materials, such as bamboo and compressed stabilized earth blocks, helps reduce dependency on resource-intensive alternatives while ensuring affordability and accessibility.

For example, retrofitting projects led by consultants in Gorkha and Kavrepalanchowk after the 2015 earthquake showcased how capacity building for local masons could enhance resilience while fostering community ownership (NRA, 2022).

c. Policy Development and Advocacy

Consultants and planners are at the forefront of influencing policies to incorporate sustainability into infrastructure development. By working closely with government agencies and donors, they help integrate sustainability into the National Transport Policy and urban development guidelines (MoPIT, 2018). This advocacy ensures that future infrastructure projects consider environmental impacts, disaster risks, and community needs.

d. Capacity Building and Community Engagement

An essential aspect of their role is empowering local communities and stakeholders. Through training programs and workshops, consultants help local engineers, masons, and contractors

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acquire skills in sustainable construction practices, such as green road engineering and bioengineering (MetaMeta, 2019). This not only enhances the quality of infrastructure but also creates livelihood opportunities for marginalized groups.

e. Challenges and Opportunities

While consultants and planners face challenges like budget constraints, resource limitations, and institutional inertia, their proactive involvement in public-private partnerships (PPPs) and international collaborations opens avenues for scaling sustainable practices. Programs like the Asian Development Bank's climate-resilient infrastructure initiatives provide critical financial and technical support to accelerate sustainable development in Nepal (ADB, 2022).

2.2 Builders and Contractors

Contractors and builders are vital in transforming sustainable construction principles into practical outcomes in Nepal's road sector and other infrastructure projects. Their responsibilities extend beyond traditional construction practices, focusing on adopting eco-friendly materials, efficient resource use, and climate-resilient methodologies to address Nepal's geographical and environmental challenges.

2.2.1 Implementation of Sustainable Techniques in Roads

a. Adoption of Green Road Approaches:

Contractors are crucial in implementing the Green Roads in Nepal (GRiN) approach, which involves using bioengineering techniques for slope stabilization and erosion control. For example, they incorporate vegetation and other natural reinforcements to mitigate environmental impacts and maintain long-term road stability (ICIMOD, 2001).

b. Climate-Resilient Construction Practices:

Builders use innovative methods like **drainage-first road construction** to manage water flow and prevent damage caused by monsoons. They also employ **low-carbon materials** like cold-mix asphalt and recycled aggregates to reduce the carbon footprint of construction activities.

c. Efficient Resource Management:

Contractors in Nepal often optimize the use of locally sourced materials, such as stone and gravel, which reduce transportation costs and environmental degradation while supporting the local economy (DFID, 2019).

2.2.2 Sustainable Construction in Other Infrastructures

a. Disaster-Resilient Building Practices:

Nepal's susceptibility to earthquakes requires contractors to focus on constructing earthquake-resistant structures. Builders implement retrofitting techniques, as mandated by Nepal's National Building Code (NBC), and use sustainable materials like bamboo and compressed stabilized earth blocks to enhance resilience (DUDBC, 2015).

b. Energy-Efficient Construction:

Builders are increasingly adopting energy-efficient designs and materials, such as insulated roofs and solar panel installations, especially for schools, hospitals, and public buildings. These measures reduce long-term operational costs and environmental impacts.

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2.2.3 Ensuring Community Engagement and Capacity Building

a. Community-Centric Projects:

Contractors play a role in hiring local labor and engaging communities in the construction process. This approach not only fosters a sense of ownership but also promotes the transfer of knowledge and skills to local workers, creating long-term sustainability.

b. Capacity Building and Training:

Builders often collaborate with consultants to train local workers in sustainable construction techniques, such as bioengineering and eco-friendly building methods. Programs like those under the Rural Access Programme (RAP) emphasize building local capacity to maintain and repair infrastructure effectively (DFID, 2019).

2.2.4 Overcoming Challenges through Innovation

a. Addressing Geographical Constraints:

Nepal's challenging topography requires contractors to innovate with modular construction techniques and prefabricated materials, enabling efficient infrastructure development in remote areas.

b. Integrating Modern Technologies:

Builders increasingly use GIS and remote sensing tools to plan construction that minimizes environmental disruption and maximizes sustainability.

c. Public-Private Partnerships (PPPs):

Contractors frequently partner with government and donor agencies to secure funding and technical expertise for sustainable construction projects, particularly in rural and underdeveloped regions.

2.2.5 Policy Compliance and Ethical Practices

Contractors and builders are responsible for adhering to Nepal's sustainability regulations, including the Environmental Impact Assessment (EIA) and guidelines set by the National Transport Policy and the National Building Code. Ethical practices, such as minimizing waste and ensuring fair labor conditions, are integral to sustainable development efforts.

2.2.6 Examples of Sustainable Practices by Contractors in Nepal

- **Road Retrofitting Initiatives:** Contractors retrofitted landslide-prone roads in Sindhupalchowk using bioengineering methods to enhance road longevity.
- **Community-Based School Construction:** Builders in Gorkha district used sustainable techniques to construct earthquake-resistant schools post-2015 earthquake, benefiting from locally sourced materials and labor.
- **Climate-Resilient Drainage Systems:** Projects under the Asian Development Bank incorporated advanced drainage solutions to withstand monsoon impacts on rural roads (ADB, 2022).

Contractors and builders are at the heart of sustainable construction in Nepal. Their role in implementing innovative, eco-friendly, and disaster-resilient practices is instrumental in addressing the nation's infrastructure challenges. By adhering to sustainability principles and engaging with communities, contractors ensure that development aligns with Nepal's goals for

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resilience, environmental preservation, and socio-economic progress. Their proactive approach can pave the way for sustainable infrastructure that serves both present and future generations.

2.3 Local Communities

Local communities in Nepal play a central role in achieving sustainable construction in roads and other infrastructure. Their involvement ensures that development projects are not only technically sound but also socially inclusive, environmentally conscious, and aligned with local needs. Empowering communities leads to better ownership, long-term maintenance, and sustainability of infrastructure.

2.3.1 Participation in Planning and Decision-Making

a. Community-Driven Planning

Involving local communities in the early stages of project planning ensures that infrastructure development reflects their needs and priorities. For example, in the Rural Access Programme (RAP), community consultations were critical in selecting road alignments that minimized environmental impacts and served the largest number of beneficiaries (DFID, 2019).

b. Advocacy for Sustainable Practice

Local communities often advocate for practices that protect natural resources, such as preserving forests during construction and ensuring proper water management. Their input ensures that infrastructure aligns with local ecological conditions and cultural values.

2.3.2 Contribution to Construction Activities

a. Labor Force for Sustainable Construction

Communities frequently provides labor for construction projects, particularly in rural areas. In projects like the Green Roads in Nepal (GRiN), community members were trained to implement bioengineering techniques, such as planting vegetation and constructing drainage systems, to stabilize slopes and protect roads from landslides (ICIMOD, 2001).

b. Use of Local Materials:

Community involvement in sourcing local materials, such as stone, sand, and timber, reduces the environmental footprint of construction and supports the local economy. In earthquake reconstruction projects in Gorkha and Sindhupalchowk, communities contributed locally available materials for rebuilding schools and houses (NRA, 2022).

2.3.3 Capacity Building and Knowledge Transfer

a. Training Programs

Communities gain valuable skills through training programs conducted during infrastructure projects. For instance, in the retrofitting training programs conducted in Gorkha, Makawanpur, and Kavrepalanchowk, participants learned techniques for making buildings earthquake-resistant, which they later applied to other community projects.

b. Local Expertise in Maintenance

Once trained, community members can handle basic maintenance tasks, reducing reliance on external contractors. For example, in the **Rural Roads Maintenance Programme**, communities took charge of repairing minor damages; ensuring roads remained functional year-round (DFID, 2019).

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2.3.4 Environmental Conservation and Sustainability

a. Preservation of Local Ecosystems

Communities plays a key role in identifying and protecting sensitive ecological areas during construction. In road projects near national parks like Chitwan, local groups ensured that wildlife corridors were maintained, minimizing ecological disruption (ICIMOD, 2001).

b. Implementation of Bioengineering Solutions

Community participation is crucial in bioengineering efforts, such as planting trees and grass on road embankments to control erosion. These efforts improve the durability of infrastructure and enhance environmental resilience.

2.3.5 Ownership and Long-Term Maintenance

a. Community-Based Maintenance Systems:

Infrastructure projects with active community involvement in maintenance have proven to be more sustainable. In the Kaligandaki Corridor Project, local groups were organized to monitor drainage systems and clean culverts, ensuring the road's longevity (ADB, 2022).

b. Disaster Preparedness and Response:

Communities trained in disaster-resilient construction are better prepared to respond to natural hazards. In the aftermath of the 2015 earthquake, communities that had been involved in building earthquake-resistant houses were able to repair damages more quickly and efficiently (NRA, 2022).

Local communities are indispensable partners in sustainable construction in Nepal. Their active participation in planning, implementation, and maintenance ensures that infrastructure projects are inclusive, resilient, and environmentally sustainable. By empowering communities with skills, knowledge, and resources, Nepal can achieve long-term infrastructure sustainability while fostering local ownership and socio-economic development.

2.4 Government and Policy Makers

The government and policymakers play a crucial role in driving sustainable construction in roads and other infrastructure in Nepal. Their contributions involve formulating policies, allocating resources, ensuring compliance, and fostering collaboration among stakeholders. Below is a detailed analysis of their roles with examples and citations.

2.4.1 Policy Formulation and Strategic Planning

a. Development of National Policies and Guidelines

The Government of Nepal has established policies such as the National Transport Policy (2001) and the National Urban Development Strategy (2017) to promote sustainable infrastructure. These policies emphasize environmentally friendly construction, equitable access, and climate resilience.

b. Strategic Infrastructure Planning

Policymakers prioritize infrastructure projects that align with Nepal's long-term development goals, such as the 15th Five-Year Plan (2019-2024), which emphasizes sustainable road networks, renewable energy integration, and resilient public buildings (NPC, 2019). The

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Strategic Road Network (SRN), managed by the Department of Roads (DoR), focuses on expanding all-weather roads while minimizing ecological disruption.

2.4.2 Regulatory Framework and Standards

a. Enforcing Sustainable Construction Codes

The Nepal National Building Code (NBC) mandates the use of earthquake-resistant designs and sustainable practices in infrastructure projects. Government agencies enforce compliance with these standards to ensure resilience and safety (DUDBC, 2015).

b. Environmental and Social Safeguards

Policies such as the Environmental Protection Act (EPA, 2019) require Environmental Impact Assessments (EIA) for major construction projects to minimize ecological damage and uphold social equity. The construction of the Kathmandu-Terai Fast Track followed EIA requirements to mitigate deforestation and soil erosion during road development.

2.4.3 Funding and Resource Allocation

a. Government Budgets for Sustainable Projects

The government allocates significant funds for green infrastructure development, such as bioengineering in road construction and the integration of renewable energy in public buildings.

b. Mobilizing International Support

Policymakers secure financial and technical assistance from international organizations like the Asian Development Bank (ADB) and the World Bank for sustainable infrastructure projects. The Kaligandaki Corridor Road Project, co-funded by the ADB, incorporates climate-resilient designs and bioengineering solutions.

2.4.4 Capacity Building and Technical Support

a. Training Programs for Local Governments and Engineers

The government conducts capacity-building programs to train local governments, engineers, and contractors in sustainable construction techniques. These initiatives improve technical expertise and foster innovation. The Post-Earthquake Reconstruction Program trained municipal engineers and planners to design and implement disaster-resilient infrastructure (NRA, 2022).

b. Establishing Research Institutions

Government-backed institutions like the Nepal Academy of Science and Technology (NAST) research and promote sustainable construction technologies, such as bamboo and earth blocks.

2.4.5 Monitoring, Evaluation, and Accountability

a. Ensuring Project Compliance

Policymakers establish oversight mechanisms to ensure that infrastructure projects comply with environmental and social safeguards. Regular audits and evaluations are conducted to measure project performance.

b. Promoting Transparency

The government uses platforms like the **Public Procurement Monitoring Office (PPMO)** to ensure transparency and accountability in awarding infrastructure contracts. In the construction

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of urban drainage systems in Pokhara, the government mandated regular reporting and community consultations to monitor progress and address local concerns.

2.4.6 Promoting Public-Private Partnerships (PPPs)

a. Encouraging Private Sector Involvement

The government creates incentives for private companies to invest in sustainable infrastructure through tax benefits and streamlined approval processes.

b. PPP Models for Sustainable Roads

Public-private partnerships have been instrumental in building climate-resilient roads, such as the Mugling-Narayanghat Highway Upgrade, which improved road safety and drainage systems.

2.4.7 Addressing Climate Change and Disaster Risk

a. Climate-Resilient Infrastructure Policies

Policies like the Climate Change Policy (2019) emphasize integrating resilience into infrastructure planning to reduce vulnerabilities to floods, landslides, and earthquakes.

b. Disaster-Resilient Infrastructure Development

The government collaborates with agencies such as the **National Reconstruction Authority (NRA)** to rebuild disaster-resilient infrastructure post-2015 earthquake. The retrofitting of schools in Gorkha and Sindhupalchowk districts under the NRA was guided by disaster-resilient policies.

2.4.8 Examples of Government Roles in Action

a. Strategic Road Expansion in Karnali Province: The government prioritized eco-friendly road construction using bioengineering to stabilize slopes and prevent landslides (NPC, 2019).

b. Building Resilience through Renewable Energy in Public Buildings: Solar-powered systems were integrated into schools and hospitals in remote districts with government incentives (AEPC, 2020).

c. Implementation of Green Roads Approach in Dhading: The government collaborated with ICIMOD to implement bioengineering solutions in rural roads, reducing environmental impacts (ICIMOD, 2001).

The government and policymakers in Nepal play a vital role in fostering sustainable construction practices. Through strategic planning, regulatory frameworks, resource allocation, and collaboration with stakeholders, they ensure that infrastructure development is resilient, inclusive, and environmentally sustainable. Strengthening policy enforcement, enhancing technical capacity, and promoting innovation will further accelerate Nepal's progress toward sustainable infrastructure development.

2.5 Environmental Organizations

Environmental organizations play a crucial role in promoting sustainable construction of roads and other infrastructure in Nepal. They work as advocates, technical advisors, and implementers to ensure that construction practices align with environmental conservation, resilience to climate change, and sustainable development goals.

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2.5.1 Advocacy for Environmental Conservation

a. Promoting Awareness and Policies

Environmental organizations lobby for eco-friendly construction policies and guidelines. They push for stricter enforcement of environmental laws, such as the Environmental Protection Act (2019), ensuring that infrastructure projects meet environmental safeguards. The World Wildlife Fund (WWF) has advocated for preserving wildlife corridors during the construction of roads near protected areas like Chitwan National Park to minimize the impact on biodiversity.

b. Public Awareness Campaigns

Organizations like ICIMOD and Clean Energy Nepal (CEN) conduct awareness programs on the importance of sustainable construction. These campaigns help communities understand the long-term benefits of environmentally conscious practices.

2.5.2 Conducting Environmental Impact Assessments (EIA)

a. Providing Technical Expertise

Environmental organizations assist in conducting EIAs for infrastructure projects. They identify potential risks to ecosystems, biodiversity, and water resources, recommending mitigation measures to ensure sustainability. The **International Union for Conservation of Nature (IUCN)** contributed to EIAs for hydropower and road projects in the Himalayas, focusing on reducing deforestation and landslide risks.

b. Monitoring Compliance with Environmental Safeguards

Many organizations monitor whether developers follow environmental safeguards during construction. They report violations and propose corrective actions to minimize environmental damage.

2.5.3 Implementing Eco-Friendly Construction Techniques

a. Bioengineering for Road Stabilization

Environmental organizations promote the use of bioengineering techniques to stabilize road slopes and control erosion. These methods include planting grass, shrubs, and trees, which enhance resilience to natural disasters. ICIMOD's Green Roads Initiative in Nepal introduced bioengineering practices that significantly reduced landslides and sedimentation along rural road networks.

b. Promoting Low-Impact Construction Materials

Organizations encourage the use of sustainable materials like bamboo, recycled aggregates, and compressed earth blocks to reduce the environmental footprint of construction.

2.5.4 Climate Change Adaptation and Disaster Risk Reduction

a. Integrating Climate-Resilient Infrastructure Design

Environmental organizations work with policymakers and engineers to incorporate climate-resilient designs in infrastructure projects. These designs help mitigate the impacts of floods, landslides, and other climate-induced disasters. The **Global Green Growth Institute (GGGI)** has supported the development of climate-resilient urban drainage systems in Nepal to address flooding in cities like Kathmandu.

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b. Promoting Renewable Energy in Infrastructure Projects

Organizations advocate for integrating renewable energy solutions, such as solar-powered lighting on roads and buildings, to reduce reliance on fossil fuels.

2.5.5 Capacity Building and Technical Support

a. Training Local Communities and Planners

Environmental organizations conduct training programs for local communities, engineers, and planners on sustainable construction practices. These programs build local capacity to implement and maintain eco-friendly infrastructure. The Alternative Energy Promotion Centre (AEPC) collaborated with environmental NGOs to train communities in designing energy-efficient buildings in rural areas.

b. Supporting Policy Implementation

Organizations like **CEN** provide technical support to government agencies for implementing policies like the National Adaptation Programme of Action (NAPA), which includes sustainable infrastructure as a key focus area.

2.5.6 Restoring Ecosystems Affected by Construction

a. Reforestation and Land Restoration

Environmental groups lead reforestation initiatives to restore areas affected by construction activities. The Hariyo Ban Program, led by WWF Nepal, worked to restore forests impacted by road development in the Terai Arc Landscape.

b. Biodiversity Conservation Efforts

Organizations ensure that road construction does not disrupt wildlife habitats by building eco-friendly solutions like animal crossings and buffer zones.

2.5.7 Monitoring and Advocacy for Sustainable Financing

a. Advocating for Green Financing

Environmental organizations promote green financing mechanisms, encouraging developers to prioritize sustainable practices. The Nepalese Forum of Environmental Journalists (NEFEJ) has advocated for environmentally friendly road projects to receive priority funding from the government and donors.

b. Partnering with International Donors

Organizations collaborates with donors like the World Bank and Asian Development Bank (ADB) to ensure funding is used for sustainable infrastructure projects. The Environmental Organizations working in Nepal in sustainable construction are as follows:

- **ICIMOD:** Pioneered the Green Roads Approach, integrating bioengineering and community participation in rural road construction.
- **WWF Nepal:** Advocated for wildlife-friendly road construction near Chitwan National Park.
- **CEN:** Conducted awareness programs on renewable energy integration in infrastructure projects.
- **Hariyo Ban Program:** Led forest restoration in areas affected by infrastructure development.

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- **IUCN:** Supported EIAs for road projects to mitigate ecological disruption in the Himalayas.

Environmental organizations in Nepal play a transformative role in ensuring sustainable construction of roads and infrastructure. By advocating for eco-friendly policies, implementing bioengineering solutions, conducting impact assessments, and restoring ecosystems, they contribute significantly to long-term sustainability. Strengthening collaboration between environmental organizations, the government, and communities will further enhance Nepal's capacity to build resilient and sustainable infrastructure.

6. Conclusion

Aligning the attitudes of consultants, builders, local communities, and other stakeholders towards sustainable infrastructure development is essential for achieving long-term environmental and economic benefits. By addressing challenges and leveraging opportunities, we can create a collaborative framework that ensures progress without compromising the planet's resources. The journey towards sustainability requires a shared commitment from all stakeholders, fostering a balance between development and conservation.

Sustainable construction represents the responsibility of the construction industry towards sustainable development. Construction activities, namely design, construction, operation, maintenance, rehabilitation, modernization and dismantling, have significant impacts on the environment. The extensive use of natural resources and energy, pollution of air, land, soils and water resources are some examples of the implications.

There are many challenges and opportunities associated with the implementation of sustainable construction by the construction industry. Indeed, balancing economic and sustainability objectives is far from easy.

Generally, empirical evidence shows that the most significant challenges associated with environmental management include increase in costs, lack of environmental awareness, lack of environmental education and training (both technical and managerial), need for change management, lower supply of green materials and components, poor environmental legislation knowledge, poor communication, and lack of commitment.

Consultants are pivotal in integrating sustainability into infrastructure projects through innovative designs, compliance with environmental standards, and strategic planning. However, the lack of local contextual knowledge and insufficient adoption of cutting-edge technologies often limits the scope of their contributions. Consultants must embrace holistic approaches that account for environmental, social, and economic sustainability.

Builders and contractors play a frontline role in implementing sustainable practices during construction. While some have adopted eco-friendly methods like using local materials and minimizing waste, widespread adoption is hindered by cost considerations, limited technical skills, and insufficient incentives. Builders need stronger enforcement of sustainable construction standards and greater access to capacity-building opportunities.

Local communities are crucial stakeholders in ensuring infrastructure aligns with local needs and environmental preservation. They actively contribute labor, local knowledge, and

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materials. However, their participation is often limited by inadequate awareness and insufficient inclusion in decision-making processes. A more inclusive approach is necessary to harness their potential fully.

Environmental organizations, government bodies, and international donors advocate for sustainability, monitor compliance, and provide technical expertise. Despite their efforts, the lack of coordination among stakeholders, inconsistent policy implementation, and limited financial resources often undermine their impact.

7. Recommendations

Nepal's infrastructure development is vital for economic growth and improving living standards. The country's unique geography; ranging from the lowland Terai to the Himalayan Mountains presents significant challenges for construction. With increasing urbanization and economic activity, the demand for roads, bridges, buildings, and energy infrastructure has surged. However, these developments often come at a high environmental and social cost, including deforestation, landslides, and displacement of local communities.

Nepal’s susceptibility to climate change, natural disasters (e.g., earthquakes, floods, and landslides), and limited financial resources makes sustainable infrastructure development essential. Key stakeholders including consultants, contractors, local communities, environmental organizations, and government agencies play critical roles in ensuring that infrastructure projects meet sustainability goals. The following recommendations have been drawn to ensure Sustainable Infrastructure Development in Nepal:

- Promotion of synergy between all stakeholders to ensure that environmental, social, and economic factors are considered during project design, construction, and maintenance is essential.
- Building technical expertise across all stakeholders, emphasizing sustainable practices and technologies is mandatory.
- Enforcement of existing environmental laws and development of new frameworks that incentivize sustainability while penalizing non-compliance should be initiated.
- Infrastructure projects should be aligned with local needs and actively involved communities from planning to execution stages.
- Investment is needed in research and development to explore innovative solutions, such as renewable energy integration, bioengineering, and disaster-resilient designs.
- Encourage consultants to adopt cutting-edge technologies like Building Information Modeling (BIM) and Life Cycle Assessment (LCA) to optimize sustainability.
- Prioritize designs that incorporate local materials, traditional practices, and climate-resilient approaches.
- Actively advocate for robust policies and standards that promote sustainability in infrastructure development.
- Provide comprehensive training on sustainable construction techniques, waste management, and renewable energy integration.

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- Introduce subsidies or tax breaks for contractors adopting green construction methods.
- Strengthen monitoring mechanisms to ensure compliance with environmental and safety standards.
- Conduct regular awareness programs on the importance and benefits of sustainable infrastructure development.
- Promote participatory planning approaches that actively involve local communities in decision-making.
- Train local individuals in sustainable construction techniques, enabling them to contribute effectively to infrastructure development.
- Foster collaboration between government, private sector, and NGOs to align efforts and share resources for sustainability.
- Advocate for and implement green financing mechanisms to support sustainable infrastructure projects.
- Strengthen enforcement of existing environmental and construction regulations through dedicated oversight bodies.
- Replicate successful initiatives, such as the Green Roads Approach, across more regions in Nepal.

By addressing these recommendations, Nepal can foster a culture of sustainability among all stakeholders, ensuring that its infrastructure development is resilient, inclusive, and environmentally sustainable.

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