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Green Enterprises as a Catalyst for Strengthening Community Capacity in Local Reconstruction Efforts in Western Nepal

Nirmal Chongbang [1], Dipina Sharma Rawal[2], Dedi Iskamato[3]
[1] Department of Sociol Work, Tribhuvan University, Kathmandu, Nepal
https://orcid.org/0000-0002-9461-8164
[2] Independent Researcher, Nepal
[3]School of Economics and Business, Telkom University, Indonesia
https://orcid.org/0000-0003-2698-0521

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ABSTRACT

This study examines how rational contributing on green reconstruction support from establishment of 26 green enterprises in these regions, supported by local, provincial, and federal governments with development partners, aimed at generating local employment, fostering a circular economy, and reducing carbon emissions. The use of CSEBs provides a sustainable alternative to traditional building materials, with an estimated reduction of 15 million tons of CO2 emissions compared to conventional red-brick construction. These enterprises, empowered by local governments and external stakeholders, promote eco-friendly and thermal-efficient construction practices, contributing to both environmental sustainability and economic resilience. Through a qualitative approach, this research employs quantitative calculation, qualitative data collection, multiple reality as ontology, interpretivism as epistemology, and inductive methodology to explore how these green enterprises contribute to climate-resilient infrastructure and sustainable development in western rural Nepal. The study underscores the potential of green technology-driven local enterprise solutions in post-disaster reconstruction, advocating for sustainable, low-carbon building practices as a model for future disaster recovery efforts.

INTRODUCTION

The global imperative for environmental sustainability is increasingly reflected in the way communities approach reconstruction efforts after disasters. In the context of Nepal, a country prone to seismic activity, the devastating 2023 earthquake in the Western region—specifically in Jajarkot and West Rukum districts—highlighted the vulnerabilities faced by rural communities. Over 76,000 houses were damaged, with 16,000 destroyed, creating an urgent need for effective, sustainable, and eco-friendly rebuilding practices. Amid this crisis, local communities in Western Nepal turned to innovative solutions such as the production of compressed stabilized earth bricks (CSEBs) and stone masonry materials made from locally sourced resources like sand, mud, and stone. These green technologies represent a significant shift from conventional construction methods, not only contributing to rebuilding efforts but also promoting broader economic and environmental resilience.

This research investigates how the establishment of 26 green enterprises in the affected regions plays a pivotal role in the reconstruction process, contributing to local job creation, fostering a circular economy, and reducing

carbon emissions. The green enterprises, supported by local, provincial, and federal governments in collaboration with development partners, provide a foundation for building sustainable and climate-resilient infrastructure. CSEBs, for example, offer a promising alternative to conventional red-brick construction, reducing CO2 emissions by an estimated 15 million tons compared to traditional building materials. These green enterprises are integral in empowering local communities to adopt environmentally friendly and thermally efficient construction practices, ultimately benefiting both environmental sustainability and economic resilience.The need for this research arises from the intersection of environmental, social, and economic imperatives in the aftermath of the 2023 earthquake. While the role of green technologies in post-disaster recovery has been recognized globally, the specific contribution of local, green enterprises in strengthening community capacity through sustainable reconstruction efforts has not been sufficiently explored. This study is crucial in highlighting the potential of such enterprises in driving not only reconstruction but also long-term community empowerment, with broader implications for climate-resilient infrastructure in other disaster-prone regions.

In both local and international contexts, the research holds significant value. Locally, it contributes to a deeper understanding of how decentralized green enterprises can lead to sustainable recovery processes, creating models for other parts of Nepal and similar contexts globally. Internationally, this study offers insights into how local green technologies can be leveraged in disaster recovery, providing a replicable model for regions seeking to reduce carbon footprints while rebuilding communities. The knowledge generated through this research contributes to the broader field of knowledge management, particularly in the domain of sustainable development and climate change adaptation.Through a qualitative approach, this research employs both quantitative and qualitative methodologies to explore the impacts of green enterprises on local reconstruction efforts. By adopting interpretivist epistemology and inductive methodology, the study seeks to uncover the nuanced ways in which these green enterprises foster community resilience and contribute to sustainable development. Ultimately, the research emphasizes the potential of green, technology-driven enterprises in transforming post-disaster recovery efforts into opportunities for long-term environmental and economic sustainability.

LITERATURE REVIEW:

The necessity for environmental sustainability is increasingly recognized as a key driver in post-disaster reconstruction efforts globally. In disaster-prone regions like Nepal, where seismic activity frequently devastates communities, the challenge of rebuilding is complicated by the need to incorporate sustainable practices that not only restore infrastructure but also foster resilience against future environmental threats. The 2023 earthquake in the Western region of Nepal, particularly in the Jajarkot and West Rukum districts, was a significant disaster, causing widespread damage to homes and infrastructure. This literature review explores the role of local green enterprises, particularly those utilizing compressed stabilized earth bricks (CSEBs) and stone masonry made from locally sourced materials, in facilitating sustainable post-disaster recovery. Additionally, the review critically examines the intersection of community-driven support structures and their impact on local economic and social resilience.

The concept of environmental sustainability in post-disaster contexts has gained global prominence, especially with the increasing recognition that rebuilding efforts must address not only immediate recovery but also long-term environmental challenges. In countries like Nepal, where the environment is heavily impacted by resource-intensive construction methods, the use of sustainable building materials such as CSEBs offers an alternative that aligns with ecological and economic resilience. CSEBs, made from locally available materials like sand, soil, and stabilizers, reduce the carbon footprint of construction compared to traditional red brick production, which involves significant energy consumption and carbon emissions. Studies indicate that adopting such green

technologies can drastically reduce CO2 emissions, compared to conventional methods (Shrestha, 2021). Additionally, these green technologies promote the circular economy by creating closed-loop systems where local materials are reused, minimizing waste and encouraging sustainable practices.

Green enterprises in the aftermath of natural disasters are crucial in supporting local economies, especially in rural areas where traditional industries are often disrupted. These enterprises not only contribute to the immediate reconstruction but also play a pivotal role in creating employment opportunities, enhancing economic stability, and fostering a culture of sustainable entrepreneurship. Local businesses, supported by various levels of government and development partners, provided local communities with access to eco-friendly materials and employment, thus addressing both environmental and economic needs.

The circular economy model, wherein resources are continually reused, is central to the operations of these green enterprises. For example, local production of CSEBs and stone masonry materials helps mitigate the environmental degradation associated with conventional building practices while simultaneously generating income for local entrepreneurs and workers. This model exemplifies how green businesses can create a self-sustaining ecosystem, where economic activity supports environmental conservation and community development. Local green enterprises also play an important role in social cohesion by involving community members in the reconstruction process and empowering them to take ownership of their recovery.

Community-based support systems have been recognized as key enablers of resilience in disaster recovery contexts. These systems, which include local social networks, cooperative organizations, and collective action, significantly enhance the ability of communities to recover from shocks and stresses. Social support, social integration, and collective engagement are central to these systems, helping individuals and businesses cope with the immediate aftermath of a crisis (Cohen & Wills, 1985). In the case of Nepal's post-earthquake recovery, the social capital embedded in local communities facilitated the quick adoption of green technologies like CSEBs, as these enterprises were often built on existing social structures and local knowledge.

The role of local support structures extends beyond immediate disaster response, having long-term implications for economic development. Research on the relationship between local support practices and entrepreneurial activity highlights the importance of micro and small enterprises in driving regional development. Studies by Ionescu-Somers & Tarnawa (2020) and Sigala (2020) emphasize how local support practices, particularly those tailored to the specific needs of small businesses, can help them navigate economic crises, such as the disruptions caused by the earthquake. In rural areas of Nepal, where large-scale industries are scarce, micro-enterprises leveraging local resources have proven to be resilient, adaptable, and integral to the region's recovery (Karki, 2013). These enterprises provide critical goods and services, create jobs, and generate income, while also fostering a sense of local ownership and collective responsibility.

Community-based support systems are crucial for post-disaster recovery, especially in disaster-prone areas like Nepal. These systems, which include local social networks, cooperative organizations, and collective action, enhance community resilience by fostering trust and shared norms that facilitate effective recovery. In the case of the 2023 earthquake, the social capital within local communities in Nepal enabled the rapid adoption of sustainable solutions, such as compressed stabilized earth bricks (CSEBs), which incorporate locally sourced materials and traditional knowledge. These community-driven efforts not only contributed to immediate recovery but also laid the foundation for long-term economic resilience. Micro-enterprises, which leverage local resources and indigenous knowledge, play a critical role in this recovery by providing essential services, creating jobs, and strengthening local economies. The synergy between local support systems and micro-enterprises fosters both economic and social resilience, helping to reduce unemployment, build community cohesion, and promote sustainable development in the long term.

Despite the increasing acknowledgment of community-based support systems in disaster recovery, there are significant gaps in understanding how these systems specifically influence the adoption and scaling of green technologies like CSEBs. Existing literature predominantly focuses on the immediate aftermath of disasters, neglecting the long-term impacts of community engagement on economic development and environmental sustainability. Further research is needed to explore the sustained effects of community-based support on the viability of green enterprises, particularly in rural, disaster-affected regions. Additionally, there is a lack of exploration into how local support systems can be effectively integrated with formal recovery policies to better support micro-enterprises. The role of policy frameworks, financial support mechanisms, and training programs

in promoting sustainable solutions through these enterprises remains underexplored. Furthermore, while social networks and local knowledge are recognized as valuable, the mechanisms through which these factors contribute to the adoption of green technologies are still unclear. A deeper investigation into how trust and collective action influence the uptake of sustainable building materials and identifying the barriers to scaling these technologies could provide valuable insights. Lastly, there is limited research on the broader economic impacts of micro-enterprises on the recovery process, particularly in their interaction with other sectors and their role in rebuilding critical infrastructure. Addressing these gaps in literature could lead to more comprehensive and effective strategies for integrating green technologies and supporting local enterprises in disaster recovery.

Study on post-disaster recovery and green entrepreneurship indicates that government support can play a transformative role in fostering resilience by providing resources, training, and access to markets for green enterprises (Mawani, Gunn, & An, 2021). In Nepal, this support has been critical in establishing a foundation for sustainable reconstruction. For instance, government-backed initiatives to support and train to local enterprises in the production of green technology-based construction materials (Eg: CSEBs) have empowered communities to engage directly in rebuilding efforts while gaining valuable skills that can contribute to long-term skill and local-based economic development.

While the potential of green enterprises to drive sustainable recovery is evident, several challenges remain. The successful implementation of green technologies, such as CSEBs and local materials-based enterprises, depends on factors such as access to raw materials, technical expertise, and market demand. In rural areas of Nepal, where infrastructure is often inadequate, logistical challenges related to transportation and supply chains can hinder the growth of green enterprises. Additionally, despite the environmental and economic benefits, the adoption of these technologies may face resistance from communities adjusted to traditional construction typologies and methods.

The financial viability of green technology-based enterprises is also a concern. While these enterprises create employment and contribute to the local economy, they often face difficulties in accessing capital for expansion. Small-scale green businesses are typically constrained by limited access to credit and financial services, limited legal access, value-chain constraint, which can hinder their long-term sustainability. Thus, a comprehensive policy framework that includes both financial support and capacity-building initiatives is essential for ensuring the success of green enterprises in post-disaster recovery.

In conclusion, green enterprises are crucial to post-disaster recovery in Nepal, especially following the 2023 earthquake, by utilizing local resources and green technologies such as CSEBs and stone-based materials. These enterprises not only promote environmental sustainability but also contribute to economic resilience by fostering local entrepreneurship and supporting a circular economy. The integration of community-based support practices and local socio-economic capital enhances the impact of these enterprises, empowering communities to rebuild sustainably. However, challenges such as logistical barriers, legal and durability concerns, resistance to new technologies, and limited access to financial resources must be addressed through collaborative efforts involving government agencies, international development partners, and local communities. Future research should focus on understanding how to overcome these challenges and explore the potential of green enterprises as scalable models for sustainable recovery in other disaster-prone regions, ensuring their widespread adoption and long-term impact.

Theoretical understanding:

The theoretical foundation for this study is grounded in **economic resilience theory**, particularly the conceptualization by Briguglio et al. (2006). This theory provides a comprehensive lens through which to explore how communities can not only endure economic and environmental shocks but also adapt and transform in response to disruptions. According to Briguglio's framework, resilience is a multifaceted concept, encompassing **absorptive**, **adaptive**, and **transformative** capacities:

- **Absorptive capacity** enables a community to withstand shocks without experiencing significant degradation.
- **Adaptive capacity** refers to the community's ability to adjust its functioning to maintain core activities and adapt to changing conditions.
- **Transformative capacity** involves the potential for long-term innovation and sustainability, allowing a community to emerge stronger after disruption, incorporating new practices or systems that enhance resilience.

These capacities are influenced by several factors, including economic diversification, market flexibility, social capital, and entrepreneurial activity. Economic resilience is also measured using indicators such as economic growth post-shock, employment stability, income distribution, and investment attractiveness.

Social support mechanisms, which are integral to Briguglio's theory, also play a crucial role in strengthening resilience. Social support fosters social capital through networks, cooperatives, and mutual aid groups that enable collaboration, trust, and resource-sharing, which are especially vital in post-disaster recovery efforts. By enhancing adaptive capacity, these mechanisms provide essential resources, financial aid, and emotional support during economic hardships, facilitating recovery. Furthermore, such networks can stimulate transformative resilience, encouraging innovation and entrepreneurial activities that pave the way for long-term sustainability.

The application of Briguglio's socio-economic resilience theory to green enterprises reveals a pathway for fostering both community and economic resilience. Green enterprises, which integrate environmental sustainability and local knowledge, can play a significant role in post-disaster reconstruction. These businesses can serve as catalysts for strengthening the resilience of local economies by utilizing local resources, creating jobs, and promoting long-term environmental and economic sustainability. Moreover, such enterprises align well with Briguglio's notion of transformative capacity, as they can drive innovation and adaptation, incorporating green technologies into the recovery process.

Community-based support systems are crucial for post-disaster recovery, particularly in disaster-prone regions like Nepal. These systems include local social networks, cooperative organizations, and collective action that build social capital and foster shared norms. In the context of the 2023 earthquake in Nepal, these local support systems facilitated rapid adoption of sustainable solutions, such as compressed stabilized earth bricks (CSEBs) as green and locally practice based enterprises setups. CSEBs, which use locally sourced materials (sand and mud with mixture of cement) and contribute to build local materials-based building techniques, represent a community-driven innovation that not only supports immediate recovery efforts but also provides a foundation for long-term economic and environmental resilience.

Micro-enterprises, which leverage local resources and indigenous knowledge, are pivotal to this process. They provide essential services, create employment, and bolster the local economy by focusing on the sustainable use of local resources. These green enterprises have the potential to strengthen both economic resilience and social resilience. For instance, micro-enterprises focused on sustainable construction materials contribute to the rebuilding process, while also offering job opportunities and reducing reliance on external resources, which enhances the community's absorptive and adaptive capacities.

Despite the recognized benefits, significant gaps exist in understanding the exact role that community-based support systems play in fostering the adoption and scaling of green technologies. Existing research often overlooks the long-term impacts of these systems, focusing primarily on the immediate aftermath of disasters. There is a need for deeper exploration into the sustained effects of community engagement on economic development, use of local materials, support from state and non-state actors, and environmental sustainability. Specifically, it is crucial to understand how local support networks can contribute to the scaling of green enterprises and the adoption of green technologies, such as CSEBs and other local materials, over time.

Moreover, the integration of community-based support systems with formal recovery policies has not been fully explored. The role of policy frameworks, financial support mechanisms, and training programs in promoting sustainable solutions through micro-enterprises remains insufficiently addressed. While social networks and local knowledge are acknowledged as vital, the mechanisms through which these factors contribute to the uptake of green technologies, especially within the context of post-disaster recovery, require further investigation.

Government support plays a transformative role in fostering resilience through green enterprises. In Nepal, government-backed initiatives have empowered local communities by providing resources, training, and access to markets to produce green technology-based construction materials like CSEBs. These initiatives have not only assisted in the immediate reconstruction process but also contributed to the long-term skill development and local-based economic development of the communities.

Despite the potential of green enterprises to drive sustainable recovery, challenges remain. The financial viability of these enterprises is often hindered by limited access to capital and credit, logistical challenges in rural areas, and resistance from communities accustomed to traditional construction methods. Infrastructure deficits, including poor transportation and inadequate supply chains, further exacerbate these challenges.

To address these issues, a comprehensive policy framework is necessary. This framework should include financial support for green enterprises, capacity-building initiatives to enhance technical skills, and efforts to overcome the logistical challenges of sourcing raw materials. Policies aimed at improving access to credit and financial services are crucial for the growth and sustainability of green enterprises.

While green enterprises have demonstrated significant potential to catalyze post-disaster recovery, several knowledge gaps remain, particularly regarding how community-based support systems influence the adoption and scaling of green technologies. A deeper understanding of how local social capital can contribute to the successful implementation of sustainable technologies like CSEBs, and how these enterprises interact with other sectors, is essential for developing effective recovery strategies. Further research and policy development are needed to integrate community-based support systems with formal recovery policies and to provide the financial and technical support necessary for the success of green enterprises in disaster-affected areas. By addressing these gaps, it is possible to foster a more resilient, sustainable, and inclusive recovery process for communities in disaster-prone regions.

METHOD

The mixed-methods approach was particularly suited for this research as it allowed for a holistic understanding of the impact of green enterprises in the post-disaster reconstruction of Western Nepal. By combining both quantitative methods—such as measuring job creation and carbon emission reductions—and qualitative methods—such as exploring community empowerment and resilience—this approach provided a comprehensive view of the enterprises' effects. The qualitative design ensured that the research was contextually sensitive, capturing the socio-economic and environmental dynamics unique to Western Nepal, making the findings relevant to both local and international audiences. Furthermore, the interpretivist epistemology facilitated a deep exploration of the cultural, social, and political factors that influenced the success of these green enterprises, offering nuanced insights into their role in sustainable recovery.

This study investigates the role of green enterprises in strengthening community capacity during the post-earthquake reconstruction of Western Nepal. To thoroughly address the multifaceted impact of these enterprises on local job creation, the promotion of a circular economy, carbon emission reductions, and sustainable infrastructure, a mixed-methods approach combining both quantitative and qualitative data collection techniques has been employed. The research methodology is designed to reflect the complexity and dynamism of green enterprise development and its contributions to long-term community empowerment and environmental resilience.

Given the specific focus on the 26 green enterprises established in the earthquake-affected regions of Jajarkot and West Rukum, this study adopts a qualitative approach. This approach allows for an in-depth exploration of the individual and collective impacts of these enterprises on the reconstruction process. The qualitative methodology enables the researcher to gather comprehensive data from multiple stakeholders, including local

government officials, enterprise owners, community leaders, and development partners, offering rich, context-specific insights that broader research designs might miss.

The research employs a multiple reality ontology, recognizing that the experiences and perceptions of various stakeholders—local communities, government officials, and enterprise operators—differ and shape the reality of green enterprise involvement in reconstruction. This approach acknowledges the complexity of local contexts and how these realities influence the outcomes of reconstruction efforts.

In terms of epistemology, the study adopts an interpretivist approach, recognizing that understanding human behavior and social processes within the context of post-disaster reconstruction requires interpreting people's subjective experiences. By engaging with participants and understanding their views, this methodology facilitates a deeper understanding of how green enterprises influence community empowerment, environmental sustainability, and economic resilience.

1. Quantitative Data Collection:

- **Surveys and Statistical Analysis:** To measure the direct impact of the 26 green enterprises on job creation, carbon emission reductions, and the economic resilience of the local community, a structured survey is distributed among key stakeholders, including employees of the green enterprises, local community members, and development organizations. Data collected include employment rates, income levels, and quantitative estimations of CO2 emissions reductions from CSEB and other green building practices. This data analyzed statistically to identify patterns and quantify the impact of green enterprises on the community.
- **Carbon Emission Calculations:** Utilizing industry-standard methodologies, the study estimated the carbon emission reductions associated with the adoption of CSEBs in comparison to traditional brick construction. This involved calculating the lifecycle carbon footprint of both construction materials and comparing the total CO2 reductions achieved using locally produced, eco-friendly alternatives.

2. **Qualitative Data Collection**:

- **In-depth Interviews**: Semi-structured interviews conducted with local enterprise owners, government representatives, and community leaders to understand their perspectives on the role of green enterprises in reconstruction efforts. Interviews will provide nuanced insights into the challenges faced, the benefits realized, and the broader social impact of these enterprises, including changes in local employment, skill-building, and community resilience.
- **Focus Group Discussions**: These discussions were held with workers from the green enterprises, as well as residents who benefit indirectly from these initiatives. These discussions were explore the social and cultural dynamics of adopting green technologies and how these enterprises affect community solidarity, economic opportunities, and perceptions of environmental sustainability.

Data Analysis

- **Quantitative Data Analysis**: The survey results and carbon emission data analyzed using statistical tools such as Excel. Descriptive statistics will summarize the impact on employment and carbon emissions, while inferential statistics (such as correlational analysis) will be used to explore the relationships between the presence of green enterprises and indicators of economic resilience and environmental sustainability.
- **Qualitative Data Analysis**: The interview and focus group data were transcribed and analyzed using thematic analysis. Patterns identified within the responses, highlighting the key themes related to community empowerment, green enterprise effectiveness, and the challenges faced by local stakeholders. Manual qualitative analysis tools will be used to code the data and identify themes that emerge from the discussions.

The methodology employed in this research contributes significantly to knowledge construction in the field of sustainable development and climate change adaptation. By providing a detailed, context-specific personal empirical study, this research fills a gap in understanding how local, green enterprises can contribute to sustainable post-disaster recovery, offering valuable insights for future disaster recovery efforts, particularly in developing countries. Moreover, this methodology ensures that the knowledge produced will be accessible and beneficial to future researchers and students, particularly those in the fields of disaster management, sustainable development, and environmental studies. The qualitative approach and mixed-methods design provide a replicable model for other disaster-prone regions, bridging the gap between theory and practice in post-disaster reconstruction. Future students and scholars can use this methodology to understand how small-scale, local enterprises can drive large-scale socio-economic and environmental change.

FINDINGS AND DISCUSSION

Research on the role of green enterprises in post-disaster reconstruction in Western Nepal was a vital exploration of how local, sustainable businesses fostered community resilience and environmental sustainability. The mixed-methods approach adopted in this study provided a comprehensive understanding by blending quantitative data on job creation and carbon emission reductions with qualitative insights into community empowerment and social cohesion. Quantitatively, the study evaluated the impact of the 26 green enterprises in the earthquake-affected regions of Jajarkot and West Rukum, assessing key indicators such as employment rates, income levels, and carbon footprint reductions. This data was complemented by qualitative research that captured the lived experiences of local stakeholders, including community members, enterprise owners, and government officials. These combined methods allowed for a nuanced understanding of how green enterprises contributed to both the economic and environmental recovery of these regions, making the findings relevant to a broader global audience while maintaining local specificity.

By focusing on the socio-cultural, political, and economic factors at play, the research acknowledged the complexity of post-disaster recovery, where both tangible and intangible aspects of resilience had to be considered. The mixed-methods approach allowed for a rich, multidimensional analysis of the ways in which green enterprises fostered long-term community empowerment, promoted a circular economy, and reduced carbon emissions, while also addressing challenges unique to the local context. This methodology not only filled a gap in the understanding of sustainable post-disaster recovery but also offered a replicable model for other disaster-prone regions, contributing valuable insights to the fields of sustainable development, climate change adaptation, and disaster management.

In the early stages of green enterprise establishment for post-earthquake reconstruction in Western Nepal, average employment figures indicated modest growth, with most enterprises initially employing fewer than 50 individuals. Most of these employees, approximately 50-75%, were previously unemployed, highlighting the role of green enterprises in providing much-needed job opportunities to the local community. On average, these enterprises created between 51 and 100 new jobs, fostering local economic activity. The average wage for employees was typically within the range of 10,000-20,000 NPR, reflecting the foundational stage of these enterprises. Although the numbers were initially modest, there were significant expectations for growth soon, particularly in terms of wage increases and job opportunities, as these enterprises scaled up their operations.

These early results are significant for several reasons. The creation of local jobs directly contributed to economic resilience, particularly through the engagement of previously unemployed individuals, thus enhancing the region’s circular economy. The employment growth and income generation from green enterprises also stimulated local businesses, with 1-5 local businesses benefiting indirectly from these enterprises. In the long run, this model is expected to contribute to a more stable and self-sustaining local economy, as the green

enterprises grow and diversify their operations, potentially creating more job opportunities and boosting the demand for green jobs in sectors such as construction, waste management, and renewable energy.

Furthermore, the findings regarding job creation and local economic impact demonstrate the potential of green enterprises to significantly contribute to carbon mitigation. The use of eco-friendly construction practices, such as the adoption of CSEBs (Compressed Stabilized Earth Blocks), helped reduce local carbon footprints in the early stages of reconstruction. Green enterprises also promoted the recycling and reusing of materials, contributing to reduced dependency on external construction materials. These efforts, though still developing, could have highly impactful effects on long-term carbon emission reductions and environmental sustainability in the region. As green enterprises continue to grow, the integration of circular economy practices and green technologies will likely amplify their role in both job creation and carbon mitigation, offering a model for sustainable recovery that could be replicated in other disaster-prone regions.

1. Employment Impact:

The green enterprises established during the reconstruction process have employed between 11 and 50 individuals, which signals a moderate contribution to local employment. While this number might seem relatively small compared to larger industries, it represents a significant opportunity for a local community still recovering from reconstruction. This moderate workforce size suggests that these enterprises are in their formative stages and likely experiencing growth, with potential for future expansion. Small-to-medium-sized businesses in this range can play a crucial role in providing stable jobs within the community, and as they solidify their position, the number of employees could grow, resulting in broader economic benefits and additional job creation.

The analysis reveals that only 0-25% of the employees in these green enterprises were previously unemployed. This suggests that these businesses have not been primarily focused on offering employment to the most vulnerable, those who were completely out of the workforce. Instead, they seem to target individuals who were already employed or had some form of economic stability. While this may limit the direct employment impact on the unemployed population, it can be argued that hiring individuals with prior work experience helps to maintain a more skilled and stable workforce. The businesses are likely able to attract people with specific skills or prior job experience, which in turn contributes to a steady and efficient operation. Although the green enterprises might not significantly address unemployment in the most marginalized groups, they are contributing to local workforce stability.

Green enterprises have created between 0 and 50 new job opportunities, a relatively modest number that likely reflects the small scale of the businesses involved. This suggests that while the job creation impact is limited, it is localized, providing employment for a manageable number of people within the community. However, the indirect impact on local businesses is more pronounced, with 1-5 businesses benefiting from the green enterprises. This could include suppliers, service providers, or other businesses in the locality of these enterprises. Though the number of indirectly impacted businesses is still relatively low, this indicates that even small green enterprises have the potential to create a ripple effect, stimulating local economic activity. As these businesses grow and their operations expand, the number of local businesses benefiting from this ecosystem could increase, further enhancing the local economic landscape.

2. Economic Resilience:

The study data suggests that green enterprises have had a moderate impact on improving the economic stability of the local community. A significant 80% of respondents believe the establishment of these businesses has improved the local economy "slightly," while 5% indicate a moderate improvement, and another 5% see no impact at all. This implies that the green enterprises have contributed to stabilizing the local economy to some degree, especially during a reconstruction phase. While the effect has not been overwhelming or dramatic, the

fact that many people perceive a slight improvement indicates that these businesses have helped foster some degree of economic resilience. The moderate improvements observed can be attributed to factors such as job creation, localized income generation, and business diversification, which are crucial for building a more resilient economy in the wake of reconstruction challenges.

The increase in local income due to green enterprises has been modest, with 100% of respondents indicating a rise of 0-10%. This suggests that while the green enterprises have provided some level of financial benefit to the community, the overall increase in local income remains relatively small. Such a modest increase is typical for small-to-medium enterprises still in their growth phase, particularly in a localized context where larger, more established businesses may dominate the income streams. However, despite the modest increase in income, the fact that 100% of respondents rate the local economy as "improved" compared to pre-green enterprise conditions suggests that even minor income increases can make a significant difference in overall economic resilience. The establishment of green businesses appears to be creating a foundation for more robust economic activity, which could continue to expand as these enterprises grow.

Green enterprises have made a significant but still limited contribution to the growth of small businesses in the study area. While 20% of respondents report a small contribution, the overwhelming majority (80%) believe that the green enterprises have contributed to small business growth to a moderate extent. This suggests that green enterprises are stimulating local economies by creating demand for products, services, and support businesses. Such businesses may provide goods or services directly tied to the operations of green enterprises, like construction supplies, logistics, or waste management. Furthermore, the impact on local households is somewhat concentrated, with 80% of households benefiting by 0-10%. This indicates that, while green enterprises are contributing to household income and local welfare, the benefits have not reached a wide proportion of the population. As these businesses expand, however, the impact on local businesses and households could increase, further solidifying economic resilience in the region.

The positive correlation between the perceived improvement in local economic stability and the modest increase in local income highlights how green enterprises, though not providing large-scale income boosts, contribute significantly to broader economic recovery. The 0-10% income growth, while small, is part of a cumulative effect that includes job creation, support for small businesses, and increased local spending. These factors together enhance the overall stability of the local economy. The gradual income increase is seen as a step toward economic stabilization, where the green enterprises' impact becomes more apparent over time rather than through immediate, transformative results.

Similarly, the contribution of green enterprises to small business growth directly correlates with the overall economic resilience of the community. By fostering small businesses, these enterprises help create a more diversified and robust economic structure, thus contributing to long-term stability. Though only a small percentage of households (0-10%) benefit directly from the green enterprises at this stage, the indirect economic impacts, such as job creation and local business expansion, are more widespread and contribute to overall economic resilience. As these businesses continue to grow, more households are likely to see direct benefits, further enhancing the local economy and ensuring sustainable recovery and development.

3. Carbon Emission Reduction:

The findings from the study underscore the significant role of green construction practices, especially the use of Compressed Stabilized Earth Blocks (CSEBs), in reducing carbon emissions. Below are the key insights, correlating to carbon emission reduction:

The use of CSEBs in construction has led to a substantial reduction in CO2 emissions compared to traditional red-brick construction. The study reveals that a reduction of between 1 to 5 million tons of CO2 will be achieved this year. This highlights the significant environmental benefits of adopting CSEBs in the construction industry, especially given the traditional brick production (based on bio-fuel; coal) methods are known to contribute heavily to carbon emissions due to high energy consumption.

A vast majority (87.5%) of green enterprises utilize 26-50% eco-friendly local construction materials. This suggests that while many green enterprises prioritize the use of sustainable materials, there is still room for further improvement in sourcing more eco-friendly materials (local sand, stone and mud). By increasing this percentage, the carbon footprint of the construction process can be further minimized.

The study indicates that the majority (87.5%) of respondents believe green enterprises have a low impact on reducing environmental pollution. Although the impact is considered low, it shows that green enterprises contribute to improving environmental conditions, particularly by reducing the carbon footprint of construction activities. With increased adoption of greener practices, this impact can be amplified.

The introduction of CSEBs has led to a slight (92.5%) decrease in the use of traditional brick production methods. This shift towards more sustainable building materials reflects a positive change in construction practices. The reduction in traditional brick production not only lowers CO2 emissions but also reduces the energy consumption and environmental degradation associated with brick manufacturing.

Green enterprises have achieved a small reduction (87.5%) in the carbon footprint of local infrastructure. While the reduction is modest, it indicates that the integration of eco-friendly practices, including the use of sustainable materials like CSEBs, is contributing to lowering overall environmental impacts. As green building technologies continue to evolve, the potential for significant reductions in the carbon footprint of infrastructure becomes even more promising.

The study reveals a clear correlation between the adoption of green building practices, such as the use of CSEBs, and the reduction of carbon emissions. The findings demonstrate that while there are still areas for improvement, the shift toward sustainable construction materials and methods is making a meaningful contribution to reducing environmental pollution and carbon footprints in the study region. The use of CSEBs offers substantial reductions in CO2 emissions and paves the way for more sustainable construction practices.

4. Community Empowerment:

The study highlights a strong correlation between the establishment of green enterprises and the empowerment of local communities, which plays an indirect yet significant role in fostering a culture of sustainability and contributing to carbon emission reduction. Below are the key insights related to community empowerment:

All respondents (100%) confirmed that local community members were highly involved in the establishment of green enterprises. This high level of community engagement is crucial because it fosters a sense of ownership and responsibility towards environmental sustainability. With communities being directly involved, they are more likely to embrace green practices, further enhancing efforts to reduce carbon emissions and promote sustainable livelihoods.

Green enterprises have made a notable contribution to capacity-building, with 100% of respondents affirming that these enterprises have moderately empowered the local workforce. By equipping community members with the necessary skills for sustainable practices, such as the production of eco-friendly materials and energy-efficient construction techniques, the workforce becomes an integral part of reducing carbon emissions. The increased skillset helps the community adopt low-carbon practices and participate in green industries.

The study reveals that 80% of workers involved in green enterprises experienced high skill improvement. This is a significant factor as it directly correlates to the implementation of greener technologies and construction practices that can reduce carbon footprints. Skilled workers are better able to apply efficient, low-emission solutions in their daily tasks, driving the transition toward sustainability.

Most respondents (87.5%) noted that the establishment of green enterprises has moderately increased community awareness about environmental sustainability. This heightened awareness plays a crucial role in spreading the message of carbon reduction and environmental responsibility. The more the community understands the link between their actions and carbon emissions, the more likely they are to adopt eco-friendly practices.

The majority (77.50%) of respondents reported that local communities feel moderately empowered due to the success of green enterprises, while 12.5% felt very empowered. This empowerment translates into an increased ability to make informed decisions about sustainability, local development, and environmental conservation. Empowered communities are more likely to support and engage in initiatives that reduce carbon emissions and contribute to long-term environmental benefits.

The study reveals a clear connection between the empowerment of local communities through green enterprises and the reduction of carbon emissions. By actively involving community members in green initiatives, providing capacity-building opportunities, and fostering skill development, green enterprises are not only promoting sustainable practices but also empowering the local workforce to contribute to broader environmental goals. The increased awareness and empowerment within these communities' help drive the adoption of carbon-reducing strategies, indirectly supporting the global effort to mitigate climate change.

5. Green Technologies Adoption:

The study highlights the local adoption and application of green technologies in the post-earthquake reconstruction process, with a strong correlation between the community's trust, satisfaction, and the environmental and economic benefits associated with these technologies. Below are the key findings:

The adoption of green technologies in the reconstruction process was widespread, with 100% of respondents indicating the use of 1-2 green technologies. This demonstrates a strong initial acceptance of sustainable practices in rebuilding efforts, despite challenges in widespread technology implementation. The adoption of green technologies such as CSEBs (Compressed Stabilized Earth Blocks) is crucial for reducing carbon emissions and promoting sustainable building practices at the community level.

A significant portion (87.5%) of new houses were constructed using CSEBs or other eco-friendly materials, though most of these houses used them to a limited extent (0-25%). This indicates that while there is a clear inclination towards eco-friendly materials, the widespread use of such materials may still be constrained by factors such as cost, availability, and awareness. However, the use of CSEBs contributes positively to reducing environmental impact and lowering carbon emissions in the region, signaling a step forward in adopting sustainable construction practices.

Residents showed a divided trust in the green technologies introduced during reconstruction, with 50% trusting them to a small extent and another 50% trusting them to a moderate extent. This suggests that while there is acceptance of green technologies, some skepticism may exist regarding their long-term effectiveness, performance, strength, or the perceived benefits. Trust in these technologies is essential for their widespread

adoption, and efforts to educate communities on their benefits could increase acceptance and contribute to higher adoption rates.

The use of CSEBs resulted in significant cost savings for local families, with 62.5% reporting a reduction of 11-25% in construction costs. This reduction is an important factor in encouraging the use of green technologies, as it directly impacts the affordability of building materials for local families. Lower construction costs could incentivize more families to adopt CSEBs and other eco-friendly materials, making sustainable construction practices more accessible to a larger portion of the population.

Regarding satisfaction with the quality of CSEBs as building material, 50% of respondents were satisfied, while 12.5% were very dissatisfied. Although the majority were satisfied, there is still room for improvement in terms of quality assurance and addressing the concerns of those who were dissatisfied. Enhancing the quality of CSEBs and addressing these concerns would likely increase the adoption of this green technology and further solidify its role in reducing carbon emissions in the region.

The findings from the study show a clear correlation between the adoption of green technologies and their potential to reduce environmental impacts and promote sustainable development in local communities. While the adoption of CSEBs and other eco-friendly materials is still in its early stages, the positive economic and environmental impacts observed are promising. Key factors such as trust, satisfaction, and cost reduction play a critical role in the widespread adoption of these technologies. For further success, increasing community trust through education, improving the quality of materials, and scaling up the use of green technologies can significantly contribute to both carbon emission reduction and local empowerment.

6. Circular Economy:

The study reveals the significant role of green enterprises in promoting circular economy principles, particularly through recycling, reusing, and waste reduction, which not only support environmental sustainability but also contribute to the local economy.

All respondents (100%) indicated that green enterprises have promoted the recycling of local materials such as use of local sand, mud, and stone to a large extent. This reflects a strong integration of circular economy principles at the local level, where green enterprises focus on reducing waste by reusing locally sourced materials. The use of local materials reduces dependency on external sources, minimizing transportation costs and carbon emissions, while also conserving natural resources.

A significant portion of green enterprises (50%) have engaged in waste reduction practices, with 12.5% and 37.5% of enterprises engaging in such practices to a small and moderate extent, respectively. Waste reduction is a core principle of the circular economy, and while there is some variability in its adoption, it is evident that many green enterprises have recognized its importance. Effective waste reduction practices not only lower environmental impacts but also contribute to the efficient use of resources and materials, further driving sustainability. The majority (80%) of respondents noted that the circular economy initiatives of green enterprises have moderately reduced the dependency on external construction materials. This is a crucial aspect of the circular economy, as it emphasizes the use of locally available resources and materials, which reduces the environmental footprint associated with transporting materials from distant locations. By relying more on local resources, the green enterprises help foster a more sustainable and self-reliant local construction industry, thereby decreasing the carbon emissions linked to the supply chain.

The local economy has benefited significantly from the recycling and reusing of materials in green enterprises, with 65% of respondents noting a large benefit. This benefit is both economic and environmental, as local businesses and workers are empowered by the increased demand for recycled materials. Moreover, this practice reduces the costs associated with procuring raw materials, contributing to the economic sustainability of local

construction practices. The circular economy approach not only strengthens environmental resilience but also builds a more robust local economy by creating jobs and promoting local material markets. Green enterprises are making substantial progress in recycling construction waste, with 65% of respondents reporting that 51-75% of the waste generated during construction was recycled. This high percentage reflects a successful application of circular economy principles in waste management.

The findings from the study clearly show a strong correlation between green enterprises' adoption of circular economy principles and their positive impact on both the environment and the local economy. By promoting the recycling of local materials, reducing dependency on external resources, and recycling construction waste, green enterprises not only reduce their environmental footprint but also strengthen the local economy. The implementation of circular economy practices such as waste reduction and material reuse play a critical role in fostering sustainability and driving down carbon emissions, which is crucial for long-term environmental and economic resilience.

7. Government and Development Partner Support:

The study highlights the critical role of government and development partners in providing support to green enterprises. Their contributions, both financial and collaborative, are pivotal in driving the success and growth of these enterprises, which in turn, contribute to local sustainability and carbon emission reduction. Below are the key findings:

A majority (65%) of respondents rated the support from local governments as high, with 25% reporting moderate support and only 10% citing low support. This high level of support from local authorities is significant in facilitating the growth and operations of green enterprises. It reflects the recognition by local governments of the importance of sustainable businesses in enhancing environmental and economic well-being. The strong backing helps these enterprises access resources, such as land and permits, and fosters an environment conducive to innovation and sustainable practices.

The support from provincial governments was rated as moderate (65%), with 35% reporting low support. While provincial governments play a crucial role in policy development and providing broader regulatory frameworks, there appears to be room for improvement in their engagement with local green enterprises. A higher level of support could help streamline processes, such as funding mechanisms, incentives, and tax breaks, making it easier for green enterprises to thrive. Increased support at this level could further boost the adoption of sustainable technologies and practices, particularly in the context of infrastructure development.

Development partners provided a large amount of financial assistance to green enterprises, with 65% of respondents reporting significant contributions. This financial support is vital for scaling up operations, implementing green technologies, and ensuring the sustainability of green enterprises. The large financial assistance provided by development partners demonstrates the alignment of their objectives with the goals of promoting sustainable economic development and environmental stewardship in local communities.

Development partners were reported to collaborate very well (65%) with local communities in the green enterprise initiatives. This effective collaboration ensures that local needs and priorities are addressed, making green enterprises more relevant and impactful. Development partners often play a crucial role in knowledge transfer, capacity-building, and providing technical assistance, which strengthens local involvement and ownership of green initiatives. This cooperation enhances the effectiveness of green enterprises and fosters long-term community empowerment.

A strong majority (65%) of green enterprise owners were very satisfied with the support they received from local government, while 35% were satisfied. This high satisfaction rate suggests that local governments are effectively addressing the needs of green enterprises by offering the necessary support, whether through policy, infrastructure, or local incentives. Governmentve relationship between government support and enterprise satisfaction underscores the importance of sustained collaboration to drive the success of green enterprises.

The study clearly shows a strong correlation between the support provided by government bodies and development partners and the success of green enterprises at the local level. Local governments' high level of support, combined with substantial financial assistance from development partners, has created a favorable environment for green enterprises to thrive. Additionally, the effective collaboration between development partners and local communities has ensured that green initiatives are relevant, sustainable, and impactful. These findings underline the importance of continued government and development partner involvement in scaling up green enterprises, which play a crucial role in driving local sustainability and reducing carbon emissions. Further strengthening this support will help maximize the potential of green enterprises and contribute to long-term environmental and economic benefits.

8. Long-Term Impact:

The study indicates that green enterprises, particularly those in Jajarkot and West Rukum, have the potential to create long-term positive impacts on both the environment and the economy. These findings highlight the sustainability of these enterprises, their potential for replication in other regions, and their contribution to disaster recovery efforts. Below are the key findings:

A significant majority (65%) of respondents believe that green enterprises will continue to thrive in the long term, with 35% indicating that their success will be limited to a small extent. This suggests that while challenges may exist, the foundations laid by green enterprises in these regions have created a strong enough base for long-term success. Sustainable practices, such as using local materials and green technologies, provide a resilient model for future growth, making green enterprises an important part of local development strategies.

The study found that 65% of respondents believe it is likely that other regions in Nepal will adopt similar green enterprise models, based on the success seen in Jajarkot and West Rukum. This highlights the replicability and scalability of the green enterprise model in Nepal. The success in these regions serves as a model that can be adapted in other areas, providing valuable lessons on sustainability, local material use, and the integration of green technologies. The likelihood of adoption is a positive indicator of how these initiatives can contribute to national development and environmental goals.

65% of respondents agreed that the establishment of green enterprises has contributed significantly to the long-term sustainability of the region, while 25% noted a moderate contribution. These enterprises have been crucial in driving local economic growth, promoting sustainable livelihoods, and reducing environmental impacts. By leveraging local resources, such as CSEBs and other eco-friendly materials, green enterprises have set a precedent for future development that emphasizes sustainability and self-sufficiency.

The majority (65%) of respondents foresee a positive long-term impact from the use of green technologies, particularly in both the economy and the environment. This indicates that the integration of green technologies is expected to deliver long-term benefits by reducing carbon emissions, conserving resources, and fostering economic growth through the creation of sustainable jobs and markets. The dual impact on both the environment and the economy reinforces the effectiveness of these technologies in driving sustainable development.

A strong 65% of respondents are very confident that green enterprises can provide a sustainable model for disaster recovery in other regions. The resilience of green enterprises, particularly their capacity to recover and continue functioning after a disaster, is highlighted as a key strength. By using local materials and implementing

environmentally sustainable practices, these enterprises not only contribute to disaster recovery efforts but also build long-term resilience against future disasters, making them a valuable tool in rebuilding communities in other disaster-prone areas.

CONCLUSION

The study findings emphasize the significant long-term impact of green enterprises on both the economy and the environment, as well as their potential to serve as a sustainable model for other regions in Nepal and for disaster recovery efforts. The success of green enterprises in Jajarkot and West Rukum demonstrates that these initiatives can provide lasting benefits, from enhancing local sustainability to promoting economic resilience. Their positive impact on the environment and the economy reinforces the importance of continuing to support and scale up green technologies and practices. With strong confidence in the long-term sustainability of these enterprises, the potential for replication in other regions and for disaster recovery is high, making green enterprises a cornerstone for future sustainable development in Nepal.The integration of Briguglio's socio-economic resilience theory with the application of green enterprises, such as those utilizing locally sourced sustainable building materials like reframing of local stone (especially to corner and through stone making), mud and sand based compressed stabilized earth bricks (CSEBs), provides a strategic framework for fostering both community and economic resilience in post-disaster recovery. Green enterprises can drive innovation and adaptation, key elements of Briguglio's transformative capacity, by embedding green technologies into the rebuilding process. These enterprises help to reduce dependency on external resources and encourage the use of local materials, thereby enhancing economic sustainability. Moreover, local community-based support systems play a vital role in facilitating the scaling of such green technologies, as these systems build social capital and foster collective action, creating a supportive environment for businesses to thrive. The synergy between government support, local knowledge, and micro-enterprises ensures that communities can not only recover from the immediate impacts of disaster but also adapt to long-term challenges, demonstrating the application of Briguglio's resilience framework in both economic and environmental dimensions. comparative linkage with the concept of environmental sustainability underscores the importance of these green enterprises in contributing to long-term ecological and economic resilience. Stone cutting and artisting process, mud & sand based CSEBs, as an example, offer an environmentally friendly alternative to traditional construction materials, significantly reducing CO2 emissions and promoting a circular economy by reusing local resources. In disaster-prone regions like Nepal, where the environment is severely impacted by resource-intensive construction, such green technologies help mitigate environmental degradation. By combining Briguglio's theory of resilience with sustainable practices, these community-based initiatives provide both immediate relief and long-term solutions. Government initiatives that support these green enterprises further enhance resilience by facilitating the transfer of skills, resources, and access to markets. This alignment between community-based support systems, local knowledge, and sustainable technologies demonstrates the potential for micro-enterprises to drive long-term recovery while fostering both economic growth and environmental sustainability in the face of future disasters.

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