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Adopting Eco-Friendly Construction Materials for Climate Resilience: Insights from a Community Seminar in Puerto Princesa

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ABSTRACT

The introduction of eco-friendly construction materials is essential for addressing the environmental and economic challenges faced by the construction industry, which traditionally relies on materials like concrete and steel that significantly contribute to greenhouse gas emissions and resource depletion. This article discusses insights obtained from a community seminar focused on sustainable construction practices in Barangay Cabayugan, Puerto Princesa, Philippines aimed at promoting climate resilience. Pre-planning assessments identified concrete mixture preparation as the community's top priority, guiding the implementation of targeted seminars and workshops. The community extension activity centered on producing eco-friendly concrete hollow blocks (CHBs) and Earthblocks (Bricks), representing a significant advancement in sustainable practices. Training sessions enhanced participants' skills, empowering them to engage in real construction activities. Participants reported substantial savings on construction materials, allowing them to undertake previously unaffordable home improvement projects. By incorporating sawdust, the initiative not only addresses waste management concerns but also provides an innovative construction solution for communities with limited access to new technologies. The enthusiasm and active involvement of participants demonstrate a growing commitment to sustainability. Positive outcomes from these activities address common community challenges and plans for follow-up workshops and partnerships with local businesses aim to ensure a consistent supply of materials and create livelihood opportunities to combat poverty. This initiative fosters community engagement in the utilization of eco-friendly construction methods, contributing to a healthier environment and promoting sustainable development.

Keywords: Eco-friendly construction materials, Sustainable building practices, Community-based initiatives, Climate change adaptation, Sustainable Development Goals (SDGs).

INTRODUCTION

The introduction of eco-friendly construction materials is crucial in addressing the environmental and economic challenges faced by the construction industry. Traditional materials like concrete and steel significantly contribute to greenhouse gas emissions and resource depletion, necessitating the shift toward sustainable alternatives. Emphasizing the adoption of circular economy principles and sustainable building materials [1][2] plays a pivotal role in promoting eco-friendly construction practices. This transition is further supported by technological innovations in the supply chain of environmentally friendly materials, which enhance their availability and sustainability [3]. For instance, the incorporation of Rice Husk Ash (RHA) into Recycled Concrete Aggregates (RCA) improves the compressive and flexural strength of concrete while addressing environmental concerns [4]. Similarly,

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naturally treated Philippine bamboo species present a viable alternative to steel bars, offering both sustainability and performance benefits [5]. Innovations such as geopolymerization using agricultural byproducts, including Coconut Husk Ash and Rice Husk Ash, enhance the compressive strength of silty clay, making it suitable for sustainable wall construction [6]. Moreover, the use of Morinda citrifolia (Noni) leaf extract as a corrosion inhibitor promotes eco-friendly solutions for steel-reinforced concrete in saline environments [7]. Finally, optimization techniques for self-compacting concrete using response surface methodology demonstrate the potential to improve material sustainability and overall construction practices [8]. Collectively, these advancements highlight the transformative impact of sustainable materials in fostering a resilient and environmentally conscious construction industry.

This article presents insights gained from a community seminar focused on sustainable construction practices and the benefits of eco-friendly materials. The series of seminars and workshops held in Barangay Cabayugan, Puerto Princesa represents a targeted initiative to integrate sustainable construction methods at a grassroots level. These efforts aimed to address climate resilience challenges while promoting alternative building materials that are both cost-effective and environmentally friendly. Barangay Cabayugan, with a population of 3,754 as per the 2020 census, faces significant economic challenges, including a high poverty incidence, where over 9% of families fall below the poverty line. Despite these challenges, the barangay has an economically active workforce comprising 60.42% of its population, highlighting the potential for development through targeted training and capacity-building programs. However, economic instability remains a concern, with 49.38% of surveyed participants reporting no monthly income, indicating a lack of access to stable employment. This demographic reality underscores the need for community-based initiatives that enhance both economic opportunities and climate resilience. The seminar addressed two core objectives: reducing the community's reliance on traditional, high-carbon construction practices and fostering economic opportunities through skill development. The training sessions and workshops focused on practical techniques, including the fabrication of concrete hollow blocks and brick-making using locally available materials such as mud, rice husk ash, and sawdust. These materials were selected for their accessibility, cost-effectiveness, and environmental benefits, directly addressing the identified needs and gaps in the community's knowledge base. Recent studies have highlighted the eco-friendly potential of rice husk ash as a sustainable substitute in cement production [9]. Additionally, its combination with red mud in high-strength porous bricks [10] and its use alongside wood ash as sustainable additives in clay matrix bricks [11] reinforce the importance of leveraging locally available resources for sustainable construction practices. Recognizing the need for continued innovation, ongoing projects by local universities and research institutions are actively exploring new materials and methods that enhance sustainability in construction while considering Puerto Princesa's unique environmental context [12][14]. To maximize the impact of these initiatives, partnerships between government agencies, NGOs, and academic institutions have been established to develop comprehensive strategies that address both environmental conservation and economic growth through sustainable practices [13][15]. These collaborations ensure that the adoption of eco-friendly materials is not just a temporary solution but a long-term, community-driven approach to resilient and sustainable construction. Adopting eco-friendly construction materials is a crucial step toward enhancing climate resilience in Puerto Princesa. Through community engagement, policy support, and capacity building, these initiatives can contribute to a more sustainable future for the city while addressing the pressing challenges posed by climate change. The increasing use of sustainable materials in construction reflects a growing commitment to green building practices, aligning with global efforts to mitigate climate change while ensuring local resilience against natural disasters [16][17][18].

The introduction of hands-on workshops and participatory group discussions allowed attendees to actively engage, collaborate, and practice skills. [19] Highlights the effectiveness of experiential learning in engineering education, enabling participants to apply new skills through integrated approaches. [20] Explores workshops as a research methodology, emphasizing their value in facilitating active participation and hands-on learning experiences. [21] Emphasizes the role of constructionism and project-based learning in fostering collaboration and skill refinement through practical and interactive activities that align with climate change adaptation and risk reduction. This approach ensured not only knowledge retention but also empowered participants to apply these skills in their local contexts, creating a sustainable, community-driven model for development. By aligning with Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 13 (Climate Action),

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this initiative underscores its broader significance in promoting eco-friendly construction practices at the grassroots level while addressing both environmental and economic challenges.

METHODS AND METHODOLOGY

The training needs assessment conducted in Brgy. Cabayugan, Puerto Princesa, Philippines utilized a participatory approach by using questionnaires. The assessment revealed that the community prioritized concrete mixture preparation above other needs, including major carpentry, awareness of traffic rules, furniture and fixtures, minor repairs, and small-scale water impounding, with a need rating of 23.4% (see Figure 1). This indicator leads to provide a seminar, training and workshops about fabrication of concrete hollow blocks (CHB) and Bricks out of locally available materials.

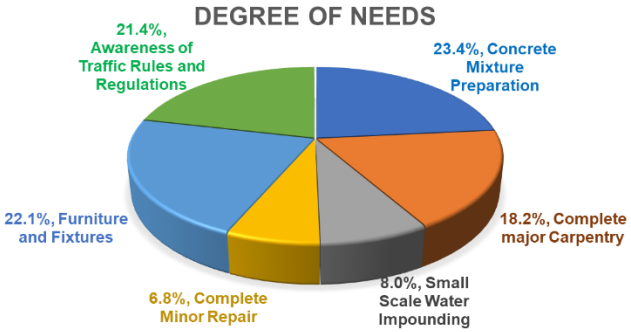

Figure 1. Result of Training Needs Assessment

In response to the communities' most needed projects, various activities were carried out from 2021 to 2024, as illustrated in Figure 2.

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Figure 2. Community Extension Services (A) 2021, (B) 2022, (C) 2023, And (D) 2024

The seminar utilized a hands-on approach, encouraging attendees to share their experiences and perspectives on eco-friendly construction materials. Presentations were complemented by interactive discussions, allowing for a comprehensive exchange of ideas. Case presentations were discussed during the seminars showcased a local project that successfully integrated eco-friendly materials. Attendees were shown the design process, material selection, and the construction techniques employed. These initiatives were continuously monitored and for the last couple of years a notable accomplishment was done through the application of the training and workshops on CHB fabrications through applying to actual building depicted in Figure 3.

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Figure 3. Utilization of fabricated CHB into Building (End-result of CHB fabrication workshop)

RESULTS AND DISCUSSION

The programs implemented were assessed to determine its impact on the community, as presented in Table 1. The assessment revealed that the training sessions and seminars conducted by the proponents had a positive effect. Residents demonstrated a significant improvement in their knowledge and skills regarding the use of eco-friendly materials, such as mud and sawdust, as additives in Concrete Hollow Block (CHB) production. Female participants initially viewed CHB fabrication as a male-only task, but their perspectives changed after the training, enabling them to fabricate CHBs themselves. This empowerment allowed them to assist their husbands with home improvements and other construction projects.

Furthermore, Participants indicated that the extension activities had a beneficial effect on their economic, social, and environmental conditions. Through these initiatives, Participants confirmed that this intervention helped them save on construction materials for home improvements, increased community engagement, and increased their awareness of environment conservation and sustainable practices as well as waste reduction.

Table 1: Impact of Extension Program.

Project	**Impact**	
	Knowledge, Attitude & Practices	**Economic, Social & Environment**
Fabrication of Concrete Hollow Blocks and Bricks Making with Sawdust	1. Enhancement of knowledge and skills in relation to the use of eco-friendly resources like mud and sawdust as an additive to CHB 2. Women empowerment	1. Cost reduction 2. Job Creation 3. Local business growth 4. Increased community engagement 5. Increased their awareness of environment conservation and sustainable practices 6. Waste Reduction 7. Women empowerment

Several challenges were encountered, such as the availability of materials particularly sawdust, since there are limited sources. Another issue is that participants had varying knowledge and experience with construction, necessitating additional time for instruction and practice. However, the assessment emphasized that CET-CE actively monitored these initiatives, leading to continual improvements in the program.

CONCLUSION

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The community extension activity focused on producing eco-friendly concrete hollow blocks, which marked an important advancement in promoting sustainable practices in our community. The training sessions significantly improved participants' skills and knowledge in the fabrication of eco-friendly hollow blocks, empowering them to engage in actual construction practices. This aligns with Toochukwu's emphasis on balancing cost efficiency, environmental impact, and stakeholder collaboration in sustainable construction practices [22]. Similarly, Bashir et al. highlight the importance of implementing green building materials in developing nations to mitigate environmental impacts such as air pollution and greenhouse gas emissions [23], reinforcing the relevance of integrating sustainable construction practices into national policies. Moreover, Villapa emphasize the role of environmental management systems in evaluating contractor performance, underscoring the need for sustainable construction approaches that align with industry standards and environmental regulations [24]. The hands-on experience with eco-friendly hollow block fabrication provided participants with practical skills, enabling them to implement sustainable construction methods effectively, aligning with Ejidike's research on utilizing hydraform bricks as alternative construction materials in tropical regions [25]. Additionally, Bredenoord discusses the technological challenges and advancements in sustainable building materials for low-cost housing, particularly regarding bamboo, earth-block technologies, recycled building materials, and improved concrete panels [26]. The training addressed these challenges by introducing participants to innovative materials and techniques, thereby enhancing their capacity to apply sustainable practices in real-world construction projects. Collectively, these studies support the notion that equipping individuals with practical skills in sustainable construction not only empowers them but also contributes to broader environmental and economic benefits. The training program exemplifies how local initiatives can foster economic opportunities, environmental responsibility, and community resilience through sustainable construction methods. Participants reported substantial savings on construction materials, enabling them to undertake home improvement projects that were previously unaffordable. By utilizing sawdust, it addresses the waste management concerns while offering an innovative construction solution for local communities lacking access to new technologies. The enthusiasm and involvement of participants reflect a growing commitment to sustainability. The positive outcomes from these extension activities address common challenges faced by the community. Further plan is to organize follow-up workshops and seek partnerships with local businesses to ensure a consistent supply of materials and create livelihood to solve poverty. This initiative creates and encourages community to foster sustainability through utilization of the locally eco-friendly construction methods and materials and contributes to a healthier environment.

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Data Availability: The data that support the findings of this study are available from the relevant public repository/ datasets link.

Conflict of interest: The authors declare that there is no conflict of interest.

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