Sustainable Community Development Through Renewable Energy Education: A CSR-Based Collaborative Approach in Pulau Ketam Malaysia

Sri Rahayu, Elfitra Desy Surya, Rosasmanizan Binti Ahmad, Faisal

Abstract

The urgent demand for sustainable community development requires innovative approaches that integrate human resource development (HRD), renewable energy education, and corporate social responsibility (CSR). This study investigates the collaborative CSR initiative between Universitas Pembangunan Panca Budi (UNPAB), Indonesia, and Tuanku Syed Sirajuddin Polytechnic (PTSS), Malaysia, in empowering the local community of Pulau Ketam through renewable energy education. Employing a mixed-method design, data were collected through surveys, focus group discussions, and field observations involving fishermen, farmers, and small-scale entrepreneurs. The CSR program included training modules on solar panel installation, biogas utilization, and micro-hydro systems. Quantitative analysis revealed significant improvements in participants' technical competencies, while qualitative findings highlighted enhanced awareness of conservation practices and stronger community engagement in forest preservation. The results demonstrate that renewable energy education not only strengthens local green skills but also contributes to environmental sustainability and economic resilience. This research proposes a CSR-based HRD model that links renewable energy education with conservation objectives, offering a replicable framework for sustainable community development in Southeast Asia and beyond.

Keywords: Sustainable Community Development, Renewable Energy Education, Corporate Social Responsibility (CSR), Human Resource Development (HRD)

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Introduction

The global pursuit of sustainable development emphasizes the integration of environmental preservation, economic resilience, and social empowerment. One critical dimension of this agenda is the promotion of renewable energy education, which strengthens local competencies while addressing ecological challenges. According to the United Nations Sustainable Development Goals (SDGs), access to affordable and clean energy (SDG 7) is a pivotal driver for reducing poverty, improving livelihoods, and supporting climate action [1].

Human Resource Development (HRD) plays a vital role in this context by equipping communities with the knowledge, skills, and attitudes necessary to adopt green technologies [2]. HRD in sustainability is not merely focused on enhancing technical capabilities but also on fostering environmental stewardship and long-term community resilience [3].

Education on renewable energy provides green skills that prepare communities for workforce transformation in the era of energy transition. Studies have highlighted that community-based renewable energy programs can significantly enhance energy literacy and promote behavioral change toward sustainability [4], [5]. For rural and coastal communities, such as Pulau Ketam, renewable energy education also reduces dependence on fossil fuels while promoting environmentally friendly livelihoods.

Corporate Social Responsibility (CSR) has emerged as an effective mechanism to integrate private sector involvement with community development and conservation. Collaborative CSR programs between academic institutions and industries have been proven to deliver long-term impacts in capacity building, particularly when aligned with sustainable energy and environmental conservation objectives [6], [7]. Cross-border CSR collaboration further strengthens knowledge exchange and resource mobilization, fostering innovation in community empowerment [8].

In this study, a CSR initiative was collaboratively developed by Universitas Pembangunan Panca Budi (UNPAB), Indonesia, and Tuanku Syed Sirajuddin Polytechnic (PTSS), Malaysia, focusing on renewable energy education for the Pulau Ketam community. The program provided training modules on solar panels, biogas, and micro-hydro technologies. This paper aims to analyze how CSR-based renewable energy education contributes to sustainable community development by enhancing human resource capacity, promoting green skills, and supporting local conservation practices.

Literature Review

A. Human Resource Development and Sustainability

Human Resource Development (HRD) is increasingly recognized as a strategic driver for sustainable development. Dessler [9] defines HRD as the process of improving employee skills, knowledge, and performance through structured learning and capacity building. In the context of sustainability, HRD not only supports technical skill advancement but also emphasizes value formation and social responsibility [10]. Gibson [11] further highlights that HRD initiatives are essential in building resilience, adaptability, and innovative capacity within communities to address global environmental challenges. Thus, integrating HRD with sustainability ensures that individuals are empowered to participate actively in energy transitions and conservation programs.

B. Renewable Energy Education and Green Skills

Education is central to accelerating renewable energy adoption. Studies suggest that renewable energy literacy significantly influences community participation in sustainable practices [12]. Integrating renewable energy education into local training programs enhances awareness, technical competencies, and readiness for green jobs [13]. Furthermore, the development of "green skills"—which include technical expertise in solar, wind, and bioenergy systems, alongside environmental stewardship—is vital for preparing the workforce for the low-carbon economy [14]. For coastal and rural communities, such as Pulau Ketam, renewable

energy education provides opportunities for economic diversification, resilience against climate risks, and long-term sustainability [15].

C. CSR and Community-Based Conservation

Corporate Social Responsibility (CSR) has evolved from philanthropy into a strategic mechanism for sustainable community engagement. Collaborative CSR initiatives between higher education institutions, governments, and industries enhance resource mobilization and innovation in community-based conservation [16]. Cross-border CSR programs, particularly those addressing environmental education, have been shown to deliver significant impacts in biodiversity preservation and community empowerment [17]. Specifically, CSR initiatives in forest and coastal conservation highlight the potential of integrating renewable energy solutions to reduce environmental degradation while providing alternative livelihood opportunities [18], [19].

In the case of Pulau Ketam, CSR collaboration between Universitas Pembangunan Panca Budi (UNPAB), Indonesia, and Tuanku Syed Sirajuddin Polytechnic (PTSS), Malaysia, demonstrates the effectiveness of combining academic knowledge with practical interventions. This partnership underscores the role of CSR as a catalyst for renewable energy education, HRD enhancement, and ecological preservation [20].

Research Methodology

A. Research Design

This study employed a mixed-method design combining quantitative and qualitative approaches to ensure comprehensive analysis. The quantitative component was conducted through a structured survey, while the qualitative aspect utilized Focus Group Discussions (FGD), in-depth interviews, and field observations in Pulau Ketam. This combination allowed triangulation of data and improved the reliability of the findings [21].

B. Population and Sample

The population consisted of local stakeholders, including fishermen, farmers, small business owners (UMKM), and youth groups in Pulau Ketam. A purposive sampling method was applied to select 120 participants representing diverse community groups. For the survey, 90 valid responses were collected, while 30 participants were actively engaged in FGD and renewable energy training sessions.

C. Instruments

The research instruments included:

1. Survey Questionnaire: Designed using a five-point Likert scale to measure respondents' competencies in renewable energy knowledge, attitudes toward sustainability, and perceived readiness for green jobs.
2. Renewable Energy Training Module: Covering practical aspects such as solar photovoltaic (PV) installation, biogas utilization, and micro-hydro systems.

Interview Guide: Used for semi-structured interviews to capture perceptions, challenges, and expectations from community leaders and CSR stakeholders.

D. Data Collection

Data were collected in three stages:

1. Pre-Training Assessment (Pre-Test): Measuring baseline knowledge and attitudes toward renewable energy and conservation.
2. Implementation: Conducting training, hands-on practice, and FGD sessions facilitated jointly by UNPAB and PTSS experts.

3. Post-Training Assessment (Post-Test): Measuring knowledge improvement, skill acquisition, and attitudinal change. Additionally, observations and documentation were carried out to validate the process and community participation.

E. Data Analysis

Quantitative data were analyzed using descriptive statistics and paired t-tests to evaluate differences between pre- and post-training results [22]. Qualitative data from interviews and FGDs were analyzed thematically, identifying recurring themes related to HRD, renewable energy adoption, and community conservation practices. The integration of these analyses provided insights into the effectiveness of CSR-based collaborative education initiatives.

Results

A. Improvement of Human Resource Competence

The pre-test and post-test results indicated a significant improvement in community knowledge and skills regarding renewable energy. The paired t-test analysis revealed a mean increase of 35% in renewable energy literacy scores, confirming the effectiveness of the training module. Respondents demonstrated improved understanding of solar photovoltaic installation, biogas utilization, and micro-hydro systems. This aligns with Dessler's HRD theory [9], highlighting the importance of structured learning in building sustainable competencies.

B. Adoption of Green Skills in the Community

FGD findings revealed that participants not only acquired technical knowledge but also developed green skills, including problem-solving, teamwork, and environmental stewardship. For instance, fishermen in Pulau Ketam expressed interest in using solar-powered cold storage systems for fish preservation, while farmers discussed potential applications of biogas for agricultural productivity. This resonates with previous studies emphasizing the role of renewable energy education in workforce readiness for the green economy [13], [14].

C. Strengthening Community-Based Conservation Practices

The integration of renewable energy education contributed to reinforcing community engagement in conservation activities. Community members associated renewable energy adoption with reduced dependence on fossil fuels and decreased deforestation. The CSR program also facilitated eco-tourism initiatives, linking renewable energy installations to educational tourism in Pulau Ketam. These findings are consistent with studies on CSR in forest conservation, where collaborative programs have proven effective in reducing ecological degradation [17], [18].

D. Cross-Border CSR Collaboration Outcomes

The collaboration between Universitas Pembangunan Panca Budi (UNPAB) and Tuanku Syed Sirajuddin Polytechnic (PTSS) Malaysia emerged as a key success factor. The partnership ensured the sharing of expertise, resource mobilization, and the development of a culturally adaptive curriculum. Respondents noted that the international collaboration added legitimacy and credibility to the program, thereby enhancing community participation. This reflects broader evidence that cross-border CSR initiatives foster innovation and inclusivity in addressing sustainability challenges [19], [20].

E. Challenges and Lessons Learned

Despite positive outcomes, several challenges were noted. These included limited technical infrastructure in Pulau Ketam, the need for ongoing financial support to sustain renewable energy projects, and varying levels of literacy among participants, which sometimes slowed the training process. However, these challenges also provided important lessons for future CSR initiatives: the need for tailored educational materials, capacity-building for local

trainers, and integration of renewable energy education into long-term community development plans.

Conclusion

This study highlights the critical role of renewable energy education in strengthening human resource development (HRD) and promoting sustainable community practices in Pulau Ketam. The integration of technical training, green skills development, and community-based conservation demonstrates that education serves as a bridge between sustainability goals and local empowerment.

The findings confirmed that CSR-based collaboration between Universitas Pembangunan Panca Budi (UNPAB) and Tuanku Syed Sirajuddin Polytechnic (PTSS) Malaysia significantly improved community competencies in renewable energy technologies. The program not only enhanced technical knowledge but also encouraged behavioral change, where participants linked renewable energy adoption to ecological preservation and economic opportunities.

Moreover, the cross-border CSR approach proved effective in mobilizing resources, transferring expertise, and building trust within the community. While challenges remain in infrastructure, financial sustainability, and literacy gaps, the initiative provides a replicable model for integrating renewable energy education into CSR programs aimed at sustainable development.

In essence, this study contributes to both academic discourse and practical applications by demonstrating how CSR-based renewable energy education can serve as a catalyst for human resource development and ecological conservation in vulnerable communities.

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