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Sustainable Coastal Community Empowerment through Ecology-Based Innovation in Batu Beriga Village, Central Bangka Regency

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Abstract

(1) Purpose: This study aims to analyze the forms, implications, opportunities, and challenges of ecology-based coastal community empowerment in Batu Beriga Village, Central Bangka Regency—an area where coastal residents often face marginalization and limited capacity in managing marine resources. Using Jim Ife's empowerment framework, the research emphasizes the provision of resources, opportunities, and knowledge to strengthen community resilience. (2) Methods: A descriptive qualitative method was employed, with primary data collected through unstructured interviews involving 15 informants, including village officials, community members, tourism awareness groups, and staff from the Environment and Forestry Service and the Ministry of Environment and Forestry. (3) Results: The findings reveal that empowerment was implemented through the Mangrove Planting Cash-for-Work Program, which combined livelihood restoration with environmental rehabilitation. The program involved 40 local workers who received daily wages of IDR 100,000-120,000 to plant around 1,000 mangrove seedlings across 2.5 hectares of coastline, providing both short-term income and long-term ecological benefits. Economically, it improved household resilience during the post-pandemic recovery; socially, it fostered collaboration among local institutions and strengthened environmental awareness; ecologically, it contributed to shoreline protection and biodiversity enhancement. However, challenges persist, including low community participation, limited human resource capacity, and conflicts of interest related to coastal mining. (4) Conclusion: In conclusion, the study highlights the need for integrating ecological restoration with socio-economic empowerment through participatory governance, capacity building, and livelihood diversification to sustain coastal resilience.

Introduction

Batu Beriga Village, located on the eastern peninsula of Bangka Island, has long been recognized as one of the most productive fishing grounds and a vital source of livelihood for local fishers. However, during the past decade, plans and practices of offshore tin mining including industrial permits (*Izin Usaha Pertambangan* or *IUP*) and the operation of suction dredging vessels have increasingly threatened the sustainability of marine ecosystems and the economic security of coastal residents. The community of Batu Beriga has persistently resisted these extractive incursions, with documented waves of protests and public opposition dating back to around 2006 and continuing through the most recent reports (Nopri, 2024).

This threat extends beyond an economic conflict over resource space; local studies and environmental organizations emphasize that offshore tin mining severely degrades marine ecosystems reducing water clarity and productivity, destroying fish habitats, and increasing sedimentation and pollution which directly undermines traditional fisheries and the ecological integrity of coastal conservation zones. The environmental advocacy group *WALHI* and several civil society organizations have repeatedly underscored these ecological consequences, warning that extractive industries in Bangka Belitung are eroding both biodiversity and local livelihoods (Hafidz, 2024).

Beyond the ecological dimension, the socio-political dynamics have also deepened community vulnerability. Recent socio-political analyses highlight ongoing tensions between capital interests represented by mining companies and investors and the rights of coastal populations whose livelihoods depend on the sea, a recurring pattern in Bangka since the liberalization of the tin mining sector in the early 2000s (Darmawan & Hidayat, 2024). In the specific case of Batu Beriga, academic documentation and investigative reports depict local resistance as a collective struggle to defend their living space and coastal cultural identity from the pressures of resource exploitation.

Against this backdrop, community empowerment in Batu Beriga must be grounded in three key principles: (1) the recognition and protection of traditional fishers' access rights to marine resources; (2) evidence-based environmental assessments prior to the issuance of mining permits; and (3) participatory governance mechanisms that ensure inclusivity and accountability in coastal management. These recommendations align with environmental NGOs' calls and recent research emphasizing the importance of eco-centric mining governance and meaningful public participation in decision-making.

In recent years, one of the most widely adopted innovations addressing coastal degradation has been the application of nature-based solutions, particularly mangrove rehabilitation. This approach performs dual functions strengthening ecosystem services such as shoreline protection, fish nurseries, and carbon sequestration while simultaneously fostering local economic development through labor-intensive employment, ecotourism, and value-added product initiatives (Rumondang et al., 2024; Sloey, 2025).

The Mangrove Cash-for-Work Program represents a labor-intensive innovation that integrates ecological rehabilitation with post-pandemic economic recovery, exemplifying the linkage between environmental sustainability and social resilience. Such interventions have proven pivotal in the post-COVID-19 period, where ecological restoration and livelihood improvement are pursued as complementary goals. Policy analyses further emphasize that the effectiveness of coastal resilience initiatives depends substantially on institutional capacity, inter-agency coordination, and meaningful community participation. Mindarti et al. (2025) reveal that weak coordination mechanisms and limited local engagement frequently undermine policy legitima.

These governance challenges are clearly manifested in Bangka Belitung, particularly in Batu Beriga Village, where extractive industrial interests continue to contest local community rights. Batu Beriga comprises three hamlets Beriga, Tanjung Berikat and Melingai with approximately 80% of residents relying on fisheries as their main livelihood (Ismi, 2024). Its relatively intact marine ecosystem has long supported abundant catches of fish, squid, and shrimp, contributing significantly to regional food security and economic stability. However, community resistance has intensified in response to proposed offshore tin mining projects by PT Timah, which reemerged between 2023 and 2025 after earlier disputes dating back to 2006 (Sumartono & Alza, 2025). Local alliances such as the *Persatuan Masyarakat Peduli Batu Beriga* have mobilized to defend marine ecosystems and the community's rights to sustainable livelihoods (Hafidz, 2024).

In response to these socio-ecological tensions, the Provincial Government of Bangka Belitung introduced the Mangrove Cash-for-Work Program, a labor-intensive initiative that integrates environmental rehabilitation with post-pandemic economic recovery. By providing paid employment for local workers in mangrove planting and coastal restoration, this program represents an adaptive, community-centered innovation that strengthens both environmental sustainability and livelihood resilience (Aisyah et al., 2022, Pahlevy & Siregar, 2024).

Yet, challenges persist: the community's human capital remains low, knowledge about sustainable marine resource management is limited, and social divisions due to mining conflicts hinder participation. These realities highlight the importance of combining ecological interventions with socio-political processes of conflict resolution and participatory governance (Mindarti et al., 2025).

Several previous studies provide relevant insights. Rumondang et al. (2024) in Batu Bara Regency found that declining mangrove areas have reduced ecosystem services, and they proposed an integrated socio-ecological management model combining mangrove restoration, ecotourism, and community involvement. Their work highlights the economic valuation of ecosystem services, which can be applied in Batu Beriga to strengthen advocacy against extractive industries.

Meanwhile, Suwanti et al. (2025) reported on a coastal women empowerment program in Batu Beriga, focusing on developing seaweed-based products to diversify household incomes. This micro-enterprise model shows that enhancing local product value chains can complement ecology-based restoration efforts.

Aisyah et al. (2022) demonstrated the potential of Community Action Planning (CAP) and Community-Based Tourism (CBT) in Lamungan Batu Village. Their study underlines the importance of participatory stages from initiation to evaluation in building sustainable coastal communities. For Batu Beriga, such participatory frameworks are crucial to ensure legitimacy and inclusivity in decision-making, particularly amid conflicts over tin mining.

While previous studies have addressed ecological restoration, women's empowerment, and community-based planning separately, there remains limited research on how ecology-based innovation can simultaneously serve as a conflict resolution tool, a poverty alleviation strategy, and an ecological conservation mechanism in mining-contested coastal areas. Batu Beriga presents a unique case where ecological innovation is not only an environmental necessity but also a socio-political imperative.

Therefore, this study aims to explore the forms of ecology-based coastal community empowerment in Batu Beriga Village, evaluate the implications of mangrove planting programs for local livelihoods, and identify the opportunities and challenges of implementing such initiatives within the broader context of resource conflicts and sustainable coastal governance.

Methods

This study uses a descriptive qualitative approach because it allows researchers to explore and explain ecology-based coastal community empowerment from the perspectives and experiences of stakeholders. Qualitative descriptive research is suitable for analyzing social realities and ecological practices through the interpretation of informants in natural settings (Creswell & Poth, 2021). Data are collected and synthesized into narratives that describe community dynamics, government roles, and ecological-based innovations. The research was conducted in Batu Beriga Village, Lubuk Besar District, Central Bangka Regency, during August–September 2025. This location was chosen because it represents a coastal area directly facing ecological challenges and socio-economic pressures, particularly mangrove degradation, post-pandemic livelihood recovery, and resistance to extractive industries.

A total of 12 informants were interviewed, selected through purposive sampling to ensure representation of those directly involved in or knowledgeable about ecology-based empowerment programs (Palinkas et al., 2015). The composition of informants consisted of 1 village head, 2 village officials, 5 fishermen, 2 representatives of women's groups, 1 official from the Central Bangka Regency Environment Agency, and 1 official from the Central Bangka Regency Marine and Fisheries Agency.

Data collection involved three techniques: (1) in-depth interviews with stakeholders to obtain detailed insights (Kallio et al., 2016), (2) non-participant observation of daily community activities and mangrove programs (Musante & DeWalt, 2010), and (3) documentation of policy papers, journal articles, and credible media reports (Morgan, 2022). The data were analyzed using the interactive model developed by Miles et al. (2019), which involves three interconnected steps: data reduction, data display, and conclusion drawing/verification. This iterative process ensured that the emerging interpretations reflected both ecological and social dimensions of coastal community empowerment.

To ensure data validity, this research applied triangulation across sources, methods, and theoretical perspectives. Source triangulation was achieved by cross-checking information from government officials, local communities, and NGO representatives. Methodological triangulation combined interviews, observations, and document analysis, while theoretical triangulation drew upon frameworks of community empowerment, socio-ecological systems, and public policy (Flick, 2018). This multi-angle validation process strengthened the reliability and credibility of the findings.

Result

The implementation of ecology-based coastal community empowerment in Batu Beriga Village has taken shape through the Mangrove Planting Cash-for-Work Program, which integrates environmental restoration with livelihood recovery. The program, supported by the Central Bangka Regency Government and the Bangka Belitung Provincial Environment Agency, involved 40 local workers mostly fishers and women in planting around 1,000 mangrove seedlings along 2.5 hectares of degraded coastline. Each participant earned an average daily wage of IDR 100,000–120,000, providing short-term income while strengthening long-term ecological resilience. This initiative demonstrates a practical form of community empowerment that combines local labor participation, natural resource utilization, and simple technology to promote sustainability in coastal management.

The program has produced multidimensional implications economic, social, and environmental that align with the goals of the National Economic Recovery initiative. Economically, it created short-term employment opportunities that improved household purchasing power in the post-pandemic period. Socially, it enhanced cooperation among local institutions, including the government, academia, and

communities, while raising awareness of environmental stewardship. Environmentally, the mangrove planting restored ecosystem services by reducing abrasion risks and improving coastal biodiversity. These outcomes reflect how participatory environmental programs can deliver both livelihood support and ecological benefits.

Table 1. Implications of the Mangrove Planting Cash-for-Work Program in Batu Beriga Village

Dimension	Program Activities and Results	Quantitative Indicators
Economic	Provided temporary jobs and daily wages for local residents, boosting purchasing power and reducing post-pandemic unemployment.	40 workers; IDR 100,000-120,000/day for 20-25 days
Socio-Political	Strengthened collaboration between government, academia, and communities; enhanced local participation, social cohesion, and empowerment awareness.	3 institutional actors (local gov't, university, community) involved
Environmental	Rehabilitated coastal areas through mangrove planting and environmental monitoring; improved shoreline protection and biodiversity.	1,000 seedlings on 2.5 ha (~400 seedlings/ha)

Source: Processed by the Researcher, 2025

Overall, the ecology-based empowerment model in Batu Beriga illustrates how participatory and labor-intensive environmental programs can simultaneously address poverty reduction, social empowerment, and ecological resilience. The synergy between local and national actors ensures program sustainability and supports the broader transition toward environmentally responsible community development in Bangka Belitung.

Beyond these direct outcomes, the program also opened strategic opportunities for sustainable development. Ecologically, mangrove rehabilitation enhances biodiversity, stabilizes coastlines, and supports long-term ecosystem services. Economically, the restored coastal area presents potential for community-based ecotourism, women-led seaweed processing, and other creative economic ventures. Such initiatives could be strengthened through local partnerships for example, developing a one-day ecotourism package with local fishers or promoting mangrove-based handicrafts. These opportunities illustrate that environmental conservation can serve as a foundation for livelihood diversification and local economic resilience.

Nevertheless, several challenges continue to hinder program sustainability. These include land-use conflicts between conservation and mining interests, uneven levels of community participation and awareness, and limited local human resource capacity. The persistence of offshore tin mining pressures poses an environmental and social dilemma, as short-term economic interests often outweigh ecological priorities. Meanwhile, inadequate skills and knowledge reduce the community's ability to optimize natural resource potential. Therefore, sustaining ecology-based empowerment in Batu Beriga requires consistent policy enforcement, environmental

education, and targeted capacity-building programs to ensure that local empowerment translates into enduring ecological and economic resilience.

Discussion

The coastal community empowerment program in Batu Beriga Village through the *Mangrove Cash-for-Work* initiative reflects a practical embodiment of Ife's (2013) *community development theory*, which emphasizes the integration of ecological sustainability, economic empowerment and social participation. Ife argues that genuine empowerment must balance three dimensions of development social justice, ecological responsibility and economic viability to create a self-sustaining community system. The findings from Batu Beriga confirm this multidimensional approach: ecological restoration through mangrove planting was directly linked to local livelihood improvement and collective social awareness. Thus, the program functions not merely as a post-pandemic economic intervention, but as a transformative mechanism that connects environmental care with social resilience.

Economically, the Mangrove Cash-for-Work initiative served as both a short-term safety net and a foundation for structural transformation. During the COVID-19 pandemic, when traditional fishing activities were disrupted, the program provided stable daily wages ranging from IDR 100,000 to 120,000 per worker to around 50 participants who planted and maintained approximately 1,000 mangrove seedlings across 2 hectares of degraded coastline. These empirical data align with findings from Dahuri (2020) and Makkatutu (2020), who observed that mangrove-based livelihood programs strengthen local economic recovery through labor absorption and natural resource revitalization. Compared to similar studies in North Kalimantan (Rumondang et al., 2024) and South Sulawesi (Mindarti et al., 2025), Batu Beriga's experience demonstrates higher levels of local ownership and sustained ecological awareness, attributed to consistent involvement from universities and civil society groups.

From the social perspective, Batu Beriga's empowerment process resonates with Ife's *participatory development principle*, where empowerment is achieved through inclusive decision-making rather than external imposition. The collaboration between the Central Bangka Regency Government, Muhammadiyah University of Bangka Belitung, and local fisher groups illustrates the emergence of horizontal linkages a key aspect of social capital formation. This finding is supported by Creswell & Poth (2018), who assert that empowerment programs are sustainable only when communities cultivate a sense of ownership. In comparison to empowerment models in Demak and Belitung (Suwanti et al., 2025), Batu Beriga's participatory framework stands out for integrating academic facilitation into village planning, enabling community-led monitoring and gradual capacity building among women's groups and youth organizations.

Ecologically, mangrove rehabilitation embodies a *nature-based solution* that bridges environmental protection with economic recovery. Consistent with Sloey et

al. (2025), mangrove ecosystems in Batu Beriga not only stabilize coastlines but also serve as nurseries for fish and crustaceans, thereby reinforcing fishers' livelihoods. Government monitoring by the Ministry of Environment and Forestry (Pahlevy & Siregar, 2024) confirms that this initiative contributes directly to the national coastal restoration agenda. Compared with regional programs in Karimunjawa (Saripudin, 2018) and Langkat (Aisyah et al., 2022), Batu Beriga's program shows more robust local adaptation because of its emphasis on indigenous ecological knowledge (*kearifan lokal*), where traditional fishing calendars and taboos are integrated into restoration scheduling.

However, as Ife (2013) cautions, empowerment efforts operate within ongoing tensions between *structure and agency*. In Batu Beriga, these tensions manifest in conflicts between ecological rehabilitation and extractive economic interests such as offshore tin mining. The persistence of these conflicts reflects what Miles et al. (2019) term structural contradiction where policy priorities for sustainability clash with short-term profit motives. Similar findings by Zacky (2024) and Hafidz (2024) highlight how corporate interests continue to threaten community-based ecological initiatives through environmental degradation and political lobbying. These structural pressures challenge the sustainability of empowerment outcomes, demanding stronger institutional protection and participatory environmental governance.

Moreover, challenges related to low public awareness and limited local capacity persist. While certain women's groups have advanced ecologically based product innovation (Aisyah et al., 2023), overall community understanding of ecological interdependence remains limited. This gap, as noted by Palinkas et al. (2015), stems from insufficient participatory communication and lack of structured education programs. Human resource constraints particularly in ecological management and entrepreneurship also hinder the full realization of empowerment objectives. As Perdani et al. (2025) argue, empowerment must be accompanied by capacity reinforcement mechanisms through technical training, mentoring, and facilitation. For Batu Beriga, such interventions are critical to transforming ecological initiatives into sustainable economic systems.

From the perspective of the Sustainable Livelihoods Framework, the ecology-based empowerment model in Batu Beriga strengthens multiple livelihood capitals natural, human, social, financial, and physical simultaneously (Eriksen, 2022). The cash-for-work mangrove program enhanced natural capital by restoring degraded coastlines, social capital through institutional collaboration and strengthened community solidarity, and human capital through improved technical capacity and ecological awareness. Meanwhile, the provision of daily wage opportunities and derivative livelihood ventures contributed to financial capital, while basic infrastructure improvements such as planting tracks and conservation zones supported physical capital. This multidimensional strengthening aligns with Ife's (2013) holistic community development theory, which emphasises the balanced integration of ecological sustainability, social justice, and economic autonomy as the

foundation for resilient communities. Hence, the Batu Beriga model not only restores ecosystems but also nurtures structural foundations of a self-reliant and adaptive coastal community.

Furthermore, the initiative illustrates strong alignment with the Sustainable Development Goals (SDGs), particularly Goal 1 (No Poverty), Goal 13 (Climate Action), and Goal 14 (Life Below Water). By linking short-term income generation with long-term environmental stewardship, the program embodies an integrated form of *green recovery* that supports both human welfare and ecological resilience. This experience demonstrates that poverty reduction and environmental restoration can be mutually reinforcing, offering practical lessons for Indonesia's coastal governance. Therefore, the Batu Beriga case may serve as a best practice model for implementing the *blue economy* agenda and adaptive community-based empowerment at the local level. Sustaining these outcomes will require consistent policy enforcement, multi-actor partnerships, and continuous capacity building to ensure that ecological empowerment evolves into an enduring foundation for inclusive and climate-resilient regional development.

The synthesis of these findings is summarized in Table 2, which illustrates the integrated relationship among the program, its key outcomes, emerging opportunities, and ongoing challenges.

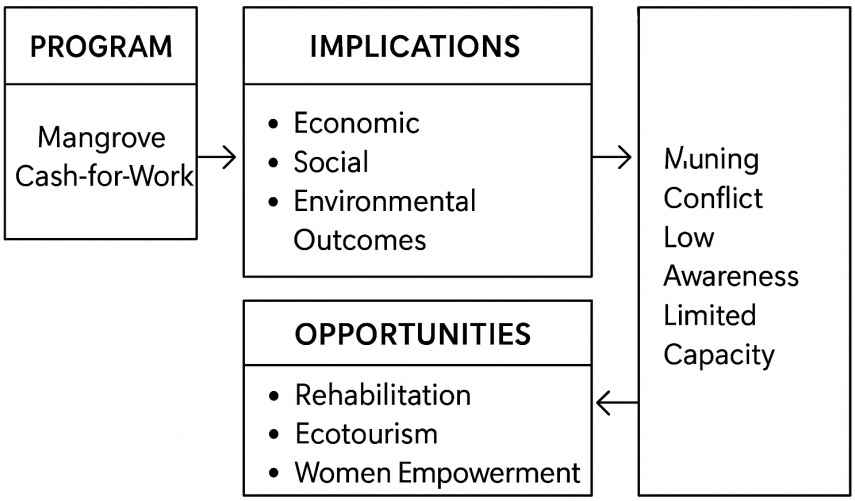
Table 2. Summary of Ecology-Based Coastal Community Empowerment Dynamics in Batu Beriga Village

Dimension	Positive Implications	Emerging Opportunities	Key Challenges
Economic	Job creation; daily wage income (IDR 100,000-120,000); improved purchasing power	Ecotourism, seaweed & mangrove-based products, microenterprise development	Dependence on external funding; market access limitations
Social	Strengthened solidarity, academic-community collaboration, women's participation	Village-based learning center, youth involvement in conservation	Uneven awareness, weak community organization
Environmental	Rehabilitation of 2 ha mangrove area (1,000 seedlings); reduced erosion	Ecosystem restoration for fish habitat, carbon storage potential	Threat from tin mining; insufficient monitoring capacity

Source: Processed by the Researcher, 2025

The interconnection between these dimensions can be visualized through a conceptual flowchart (see Figure 1) that encapsulates the cyclical relationship between empowerment programs, their implications, opportunities, and challenges.

Figure 1. Conceptual Model of Ecology-Based Coastal Community Empowerment in Batu Beriga Village



Source: Processed by the Researcher, 2025

The flowchart illustrates the interactive cycle in which the Mangrove Cash-for-Work Program generates multi-dimensional impacts that open new opportunities while simultaneously facing sustainability challenges. The balance between opportunity and constraint determines the long-term viability of coastal community empowerment in Batu Beriga.

Overall, this discussion confirms that ecology-based coastal empowerment is not a single technical activity, but rather a complex socio-ecological process shaped by policy, participation, and local wisdom. The integration of Ife theory provides a normative basis for understanding empowerment as a transformative practice that fosters autonomy, solidarity, and sustainability. For replication in other coastal areas in Indonesia, the Batu Beriga model emphasizes the importance of combining policy cohesion, academic facilitation, and participatory capacity building to achieve sustainable socio-ecological resilience. Thus, the success of Batu Beriga proves that ecology-based empowerment needs to be integrated into regional climate change adaptation policies. Local governments can adopt this model by strengthening village-based funding and university partnerships in environmental education.

Conclusion

The findings of this study indicate that ecology-based empowerment in Batu Beriga Village has been primarily realized through the Mangrove Planting Intensive Program. As a government intervention, this program not only responded to post-pandemic economic pressures by creating labor-intensive employment but also enhanced environmental awareness and contributed to mangrove ecosystem restoration. By linking ecological rehabilitation with community-based participation, the initiative provided short-term income opportunities while simultaneously fostering engagement in coastal conservation.

The impact of this program can be seen in three key aspects. From an economic perspective, it helped reduce unemployment by offering alternative jobs to villagers affected by the COVID-19 crisis. Socially, it encouraged collective responsibility and cooperation, although active participation was not evenly distributed across the community. Environmentally, the mangrove rehabilitation efforts contributed to reducing coastal abrasion and maintaining ecosystem balance, affirming the strategic role of nature-based solutions in ensuring long-term resilience.

Despite these achievements, several challenges remain, particularly the limited capacity of human resources and low public participation, which threaten the sustainability of the empowerment process. Addressing these challenges requires ongoing investment in community education, technical training, and continuous policy oversight. At the same time, the opportunities presented by the program remain substantial, particularly the potential to diversify livelihoods through mangrove-based ecotourism, fisheries development, and coastal product innovation.

In conclusion, the case of Batu Beriga demonstrates the relevance of integrating ecological restoration with socio-economic recovery. Strengthening the program in the future will require policy reinforcement through consistent supervision and adaptive regulations, community capacity-building through targeted training and socialization, as well as inclusive governance by ensuring collaboration between government, local communities, NGOs, and academic institutions. Furthermore, future research should examine how ecology-based innovations can be integrated with conflict resolution mechanisms and value-chain development, so that empowerment frameworks can be replicated and scaled up in other coastal communities experiencing similar ecological and socio-economic pressures.

Declarations

This research was carried out in compliance with established ethical standards. Throughout the study, no ethical conflicts or violations were encountered, and all procedures adhered to accepted academic research guidelines.

Authors contribution statement

The author solely conceived, designed, conducted, and analyzed this research, as well as prepared and finalized the manuscript. Data collection and interpretation were carried out directly by the author through interviews, observations, and documentation. The author extends sincere gratitude to the research participants, including village officials, fisher groups, women's groups, regional government agencies such as the Provincial Forestry and Environment Office, and local civil society organizations, whose valuable insights and experiences greatly enriched this study.

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Data availability statement

The data supporting the findings of this study are not publicly available due to privacy considerations of the informants and internal research policies. However, the data may be obtained from the corresponding author upon reasonable request.

Declaration of interests statement

The authors declare that they have no known financial or personal conflicts of interest that could have influenced the work reported in this article.

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