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Exploring the Potential of Seaweed-Based Bioplastic Production in Pangkep Islands

Wahyuni Nur Pratiwi[1], Magvira Wulandari[1], Fira Andhara Aulia[1]

[1]Politeknik Bosowa

*Corresponding Author: Wahyuni Nur Pratiwi

Email: wahyuninurp@gmail.com

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Abstract

This research aims to find out the possibility of seaweed for the production of bioplastic in the Pangkep Islands and consideration its socio-economic and environmental benefit assessments. Hailing from a qualitative paradigm, the study collected input from the relevant local stakeholder's seaweed farmers, environmental campaigners, and government or policymakers- to ascertain the patterns of opportunity and threats. Research evidence indicate that seaweed bioplastics could further income sources, improve on the sustainability, and lower reliance on standard seaweed markets. Nevertheless, technological constraints technological constraints, socio cultural issues, and lack of government support, regulatory barriers to market entry are some disturbing factors. The study also finds that it requires a multi-stakeholder engagement model to create policies for seaweed-based biopolymers to increase the chances of success. This research adds to existing literature on the development of sustainable bioplastic solutions in developing countries and the trade-off challenges that can occur during the manufacturing and consumption process.

Introduction

It is crystal clear that the problem of plastic pollution is a global issue whose effects has reached alarming figures and therefore there is a challenge of seeking sustainable options to traditional plastics. Conventional plastics mainly based on petrochemicals are known for causing critical environmental challenges such as marine pollution, global warming pollution, and detrimental impact to marine organisms (Singh et al., 2022; De Gisi et al., 2022). Approximately 8 million metric tons of plastics are dumped into the sea annually causing pollution, negative impacts on marine life as well as general ecosystem decline (Kumar et al., 2023). Such environmental considerations have deepened the quest for green materials to observe production of what can be termed as bioplastics. Bioplastics differ from other more familiar plastics in that they are sourced biologically and are environmentally friendly as well as being biodegradable in most instances.

Indonesia as the largest archipelagic country in the world has emerged as the leading priority regarding bioplastic. Seaweed, one of Indonesia's major sea products, offers great opportunity for bioplastic processing (Nagarajan et al., 2024; Santana et al., 2024). It is one of the largest global producers of seaweed; the country supplies over 38% of global supply. Apart from its numerous economic importance for the coastal communities where seaweed is farmed, it has impacts on the environment; it absorbs and stores carbon, cleans water, and restores habitats (Cotas et al., 2023; Bhuyan, 2023). Consequently, using seaweed as a sustainable feedstock source for bioplastic downstream chopping complies with both the economic goal and the environmental goal, which provide a roadmap to the fight against plastic pollution and improvement of sustainable development goals.

Pangkep islanders are residents of South Sulawesi Indonesia who are famous for seaweed farming. Seaweed farming being an economically important activity the coastal communities of the region have been mainly dependent on seaweed farming for their livelihood and

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economic growth. Hence, the expanding global market for bio-materials creates a prospect of enhancing the region of Pangkep economic vulnerability through the production of bioplastic from the locally abundant seaweed. Nevertheless, there remain several opportunities for the development of seaweed-based bioplastics in Pangkep, of which there is a paucity of literature investigating the possibilities and economic impacts of such start-ups.

The interest in seaweed as a raw material for bioplastics is due to its property's high polysaccharides, biodegradable, and renewable sources (Lim et al., 2021; Nagarajan et al., 2024). Seaweed cultivation's production does not negatively influence the food crop production because it does not require; land and water resources similar to corn and sugarcane feedstock for bioplastic production. It has also been established that seaweed-based bioplastics can have the equivalent toughness as conventional plastics and their usability has been revealed to span from packaging to horticultural films (Ayyakkalai et al., 2024; Ayala et al., 2024). In addition, seaweed farming needs little or no inputs and may be grown in coastal areas, near nutrient sources, therefore, having a very low impact on the environment. These qualities show the capacity of seaweed as a better complementary for petrochemical plastics especially at cost effective areas such as Pangkep with ample amount of seaweed availability.

All the same, achieving the vision of bioplastics derived from seaweed comes with its unique obstacle. Organisation the production process involves technical, economic and social factors that must be solved in order to successfully implement (Pozzi et al., 2023; Shet & Pereira, 2021). Other key issues affecting bioplastics are technological in nature and they comprise of technological changes in bioplastic processing, market acceptance of bioplastics and the availability of appropriate polices (Bhatia et al., 2021; Atiwesh et al., 2021). Also, with regards to seaweed farming practices, there are issues concerning dimension regarding the production of seaweed and messages left on the marine ecosystem that require consideration of ecological appropriately. Since the formation of seaweed-based bioplastic decentralised, these barriers provide by local stakeholder from seaweed farmers, industries, and policies so that the industry may continue to grow (Holland & Shapira, 2024; Rostan, 2022).

The subject of the investigation of the production of bioplastic based on seaweed in Pangkep is appropriate at the present time, knowing the trends in the development of the global plastic industry and its transition to more responsible practices. Indonesia involves in the strategy called 2019 Indonesian Marine Plastic Debris Reduction Plan of achieving up to 70 percent of the current level by 2025 reveals that the country needs proper solutions to the plastic waste issue, including a bioplastic solution. Thus, by selecting Pangkep as the central location of interest, this study seeks to establish how such local seaweed resources may be effectively utilised in the development of bioplastic, and thereby enhance the existing discourse on sustainable material advancement and economic growth.

The socio-economic benefit of developing a seaweed-based bioplastic industry on Pangkep is enjoyed. These changes might improve the value-addition, increase employment rates dependent on the new product, and improve the living standards of the people of the coastal region (Ramirez et al., 2024). However, more attention should be paid to the existing local stakeholders' attitudes toward the implementation and further maintenance of such programs (Asamoah et al., 2024). This factor entails evaluating the community to know whether they are prepared to adopt bioplastic technologies and what structures are required to enhance such change (Swain et al., 2021). Hence, unlike prior studies that focus purely on the development and analysis of bioplastic from seaweed, this research also explores the characteristics pertaining to the socio culture in relation to the acceptance of bioplastic in Pangkep.

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Method

This research investigated bioplastic manufacturing capabilities from seaweed within Pangkep Islands by assessing both social and financial consequences and environmental effects of using indigenous seaweed resources. The researchers selected a case-study methodology because it provided adequate depth to analyze intertwined aspects of seaweed agriculture and bioplastic initiatives in particular local communities. The research adopted this approach to build an in-depth comprehension of both the opportunities and challenges and existing perceptions that seaweed industry stakeholders deal with in Pangkep.

The research applied case study design as an accepted tool in qualitative investigation to analyze real-life contemporary phenomena. This design enabled researchers to thoroughly investigate the key elements that affect seaweed-based bioplastic manufacturing potential in the Pangkep Islands. The study centered on gathering the real-life experiences along with opinions and knowledge of local stakeholders who included seaweed farmers together with industry specialists and government officials.

The three-month research period from June to August 2024 enabled data collection through several qualitative research methods which provided an in-depth analysis of the research subject. The research implementation contained semi-structured interviews together with focus group discussions (FGDs) and direct observation methods. The researcher selected these methods because they allowed capturing diverse perspectives while generating wealthy detailed information on seaweed-based bioplastic production from both social and environmental and economic standpoints.

Ongoing research involved 15 participants who consisted of seaweed farmers together with local government representatives and industry experts and representatives from NGOs focused on environmental conservation. Respondents were given open-ended questions during interviews to provide unhindered detailed responses. Through these interviews researchers gained understanding about present seaweed farming methods alongside people's views concerning bioplastic production and its associated social and economic aspects along with potential obstacles. The interviews took place through direct interaction using the local language to create improved understanding between the researcher and participants.

Twelve participants consisting of seaweed farmers together with community leaders participated in two focus group discussions as part of the study. Community members participated in two FGDs to evaluate seaweed-based bioplastics as a sustainable business opportunity. Group participation during this technique allowed multiple participants to jointly add their thoughts which resulted in more extensive insights. Participants gave their consent for audio-recording during the discussions which later underwent transcription before analytical proceedings started.

Direct observations enabled the researcher to obtain deeper information about both practical aspects and local settings of seaweed cultivation and processing. The researcher observed seaweed farming methods as well as available infrastructure and coastal environmental conditions during these assessments. Data triangulation was achieved through the note-taking process during direct observations.

The researchers utilized purposive sampling to recruit participants because they possessed practical expertise in seaweed farming and bioplastic production. The designed sampling technique allowed researchers to include participants possessing extensive knowledge and providing comprehensive information about the research goals. The research team adopted specific criteria for participant selection by including stakeholders who cultivated seaweed

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while also including experts who specialized in sustainable materials and experts who managed marine resources.

Data analysis utilized thematic methods because they offer qualitative research the capabilities to both uncover and interpret data patterns (themes) as described. Researchers transcribed all data gathered through interviews and focus groups and observations and used NVivo software to code this information systematically. Thematic analysis required researchers to complete data familiarization followed by coding then move into theme development and finish with theme refinement steps. The first stage used induction to interpret data while maintaining a thematic structure that originated from the data collection rather than pre-defined categories.

The research examined core elements about seaweed-based bioplastic production by examining economic advantages alongside environmental opportunities and technological issues alongside community preparedness. The analytical team performed repeated reviews to refine themes so the results would precisely represent the gathered data. A subset of participants was involved in member checking to validate the research interpretations through a review of preliminary findings.

Result and Discussion

The growing concern over plastic pollution has intensified the search for sustainable alternatives, with bioplastics emerging as a promising solution. Given Indonesia's status as one of the world's largest seaweed producers, the potential for seaweed-based bioplastics presents both an economic opportunity and an environmental necessity. This study investigates the feasibility of producing bioplastics from seaweed in the Pangkep Islands, considering not only the technical aspects but also the socio-economic and environmental factors that influence its adoption. By engaging with local stakeholders, including seaweed farmers, policymakers, and environmental advocates, this research aims to provide a holistic understanding of the challenges and opportunities associated with developing a seaweed-based bioplastic industry in the region.

Opportunities for Seaweed-Based Bioplastic Production

Researchers from the study found various favorable prospects for producing bioplastics based on seaweed in Pangkep Islands that would boost economic prosperity and environmental conservation as well as fostering community advancement. The study showed that the Pangkep Islands have substantial seaweed resources while government policies and rising market needs for environmentally-friendly products present excellent potential to generate jobs.

Total seaweed farming land available within Pangkep Islands creates optimal conditions for industrial bioplastic manufacturing operations. The region currently specializes in seaweed farming that mainly exports its raw materials to external markets. Local stakeholders who produce bioplastics will enhance the value of their current seaweed supply chain operations. The participant who had been working as a seaweed farmer for more than ten years expressed his view on the possibility of increasing production levels.

> *"We have an abundant supply of seaweed here, but currently, most of it is sold as raw material. If we can process it into bioplastic, it would create more value and bring higher income to the farmers."*

The combination of tropical environment and nutrient-abundant Pacific Ocean waters makes seaweed grow fast enough for several annual harvests. The natural supply of raw material enabled by this advantage creates a continuous manufacturing stream that contributes to sustainable manufacturing practices.

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Local government initiatives in Pangkep direct their attention toward sustainable industrial growth which perfectly matches the prospect of seaweed-based bioplastics. The Pangkep local government demonstrates environmental project support through incentives they provide to small and medium enterprises which participate in green innovation. During the study the local official received the government support which was evident through this interview:

> *"The local government is keen on promoting industries that are both profitable and sustainable. We are willing to support bioplastic production through grants and policy incentives to encourage more businesses to explore this sector."*

Favorable policies establish excellent conditions for bioplastic manufacturing investments that allow both domestic and overseas companies to participate in industry development. The government's commitment to decrease plastic waste makes Pangkep a desirable site for conducting bioplastic manufacturing pilot projects because it supports international sustainability initiatives.

Environmental sustainability trends have created substantial market demand for sustainable plastic alternatives which provides an excellent business prospect for seaweed-based bioplastics. Participants in the study observed that an emerging market has gained momentum because of biodegradable packaging products both inside and outside the domestic boundaries. The packaging sector has experienced an emerging trend according to a local entrepreneur experienced in this field.

> *"There is definitely a growing market for sustainable products, especially in cities where consumers are becoming more environmentally conscious. If we can produce bioplastics locally, it could open up new markets for us."*

The industry is expanding due to two factors: customer choice of sustainable products alongside governmental requirements to lower plastic waste levels. The biodegradable seaweed bioplastics demonstrate a promising solution to the current environmental problems. The seaweed bioplastic industry in Pangkep has the chance to achieve market competitiveness because of growing consumer interest.

The evaluation reveals another major opportunity related to employment generation alongside local community support. The production of seaweed-based bioplastics through local dependents at various stages of farming and processing and manufacturing would drive economic growth in communities where this industry sets up shop. A local leader acknowledged the wealth of social benefits that could result from this industry operation.

> *"If we can develop a bioplastic industry here, it will not only benefit the farmers but also create jobs for the youth and women in the community. It could become a new source of livelihood for many families."*

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> *"Seaweed farming is not only good for the environment but also helps in carbon sequestration. If we can use seaweed for bioplastics, it would have a positive impact on both the economy and the environment."*

The implementation of seaweed-based bioplastics will help Pangkep achieve sustainability targets because it implements circular economy measures while decreasing carbon emissions throughout the region. The conversion of seaweed resources into sustainable production methods supports regional environmental goals which makes the conversion strategy a strategic regional opportunity.

The invention of seaweed bioplastic technologies creates new market prospects for Pangkep district. By putting more effort into research and development activities the region will obtain more effective methods for turning seaweed biomass into bioplastics. The region should form partnerships with universities research institutions and international organizations to obtain modern technologies and educational content. The marine studies specialist from the region emphasized the requirement for teamwork as per his research involvement.

> *"We are keen to collaborate with other institutions to develop the technology needed for bioplastic production. There is great potential here, but we need to invest in research and development to make it viable."*

The formation of collaborative agreements allows Pangkep to establish leadership in sustainable innovation which will attract funding along with expert knowledge to advance the bioplastic sector. The region's technological strengths will increase through this venture and sustainable development will be established permanently.

Challenges and Barriers

The future development of seaweed-based bioplastics in the Pangkep Islands faces important challenges that require immediate solutions to achieve this potential. Multiple obstacles prevent the adoption of new practices because they include technological constraints, minimal infrastructure, funding shortages, market entry challenges and cultural traditions that resist change. These barriers demand immediate attention because they determine the sustainability and successful execution of seaweed-based bioplastic initiatives throughout the area.

The key obstacle stands in the way of efficient bioplastic manufacturing due to the absence of modern technological solutions. Seaweed farmers in the area focus their activities on raw seaweed exports instead of transitioning into the production of valuable items such as bioplastics. The study established that the community has no available technology to transform seaweed into bioplastics on a production scale. The entrepreneur operating locally mentioned the following problem:

> *"We do not have the technology here to turn seaweed into bioplastic. The machines and expertise required are beyond what we currently possess, which makes it difficult to compete with larger, more advanced producers."*

Modern processing technologies together with equipment serve as essential barriers for the local community to enhance their bioplastics manufacturing capacity and product quality. The technological deficiency prevents both increased production output and higher product quality and creates challenges for local manufacturers to achieve commercial standard requirements.

At present the basic infrastructure of Pangkep Islands stands as a major hindrance for the development of a seaweed-based bioplastic industrial sector. Efficient movement of raw materials and finished products becomes difficult due to both the remote location of the area and poor transportation systems that exist there. According to government records a representative affirmed:

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> *"Our roads and transportation systems are not developed enough to support large-scale industrial activities. This affects not just the transport of seaweed but also the import of necessary equipment and materials for bioplastic production."*

Insufficient infrastructure creates barriers for supply chains as well as raises production and distribution expenses. Proper facilities for storage along with processing and transportation facilities create additional obstacles that hinder small and medium enterprises (SMEs) from obtaining competitive market positions. Business success in bioplastic production and distribution requires heavy investments into fundamental infrastructure systems which will enhance operation efficiency. The study shows a major difficulty in that local seaweed farmers along with bioplastic production entrepreneurs face inadequate financing to support their operations. Large capital is necessary for both the establishment of bioplastic production plants and the procurement of essential equipment and the undertaking of research and development tasks. The expenses related to seaweed farming troubled one farmer who spoke about it during the interview.

> *"We need a lot of capital to start bioplastic production, but access to loans and financial assistance is limited. Most of us cannot afford the high costs involved."*

Financial restrictions prevent the community from developing solutions for bioplastic production although there are clear opportunities. The absence of budget-friendly credit options makes local businesses incapable of diversifying operations because taking bioplastics expansion risks becomes too hazardous. The financial difficulties in the market prevent both the sector's general advancement and block new local business ambition.

The process of obtaining markets for bioplastic products derived from seaweed poses substantial obstacles. The expanding market demand for sustainable materials becomes an obstacle for local producers since they encounter two main barriers: established bioplastic manufacturers and strict product standards that prevent penetration into new markets both internally and abroad. Industry insiders explain that present market entry challenges exist because.

> *"Breaking into the bioplastic market is not easy. There are already big players in the industry with established distribution networks and certifications. For us, meeting those standards is a major hurdle."*

Local producers experience challenges in global business because they lack marketing expertise and their products are not properly branded or certified. The unfamiliarity of producers toward necessary regulatory requirements and quality standards for exporting bioplastic products restricts their capacity to target new markets and increase profit potential. The industry requires programs that build capacity to teach producers about market access procedures and certification protocols along with marketing strategy methods.

The seaweed-based bioplastic industry in Pangkep faces hurdles because of socio-cultural factors and resistance against new technology acceptance. The research discovered that most seaweed farmers avoid modern methods and stick to their conventional practices because they worry about uncertainties and risks in new procedures. He explained this opposition during an interview as the community leader said:

> *"Many farmers here have been cultivating seaweed the same way for generations. They are not easily convinced to try something new, especially when it involves investment and risk."*

People show resistance to bioplastic production because they lack understanding about its benefits as well as concerns about monetary setbacks. Changing traditional farming practices

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remains challenging because they run deep in the community while requiring extensive training about benefits with practical demonstrations. Socio-cultural barriers demand active community engagement and trust-building particularly with proof of new technology benefits for both the economy and natural environment.

Regional capabilities for research development (R&D) proved to be limited since it represents a crucial requirement for enhancing bioplastic production methods. Syndicate's innovation and new product development is restricted because it lacks sufficient local workers skilled in bioplastic technology. The academic researcher emphasized that the region requires support for research and development activities.

> *"We need more research on how to optimize the use of seaweed for bioplastic production. However, there is a lack of resources and expertise here to conduct such studies."*

Approaches to addressing this challenge require organization between local research institutions and universities together with industry stakeholders to improve research and development abilities. The company should invest in research to create better production methods for bioplastics which will enhance its market competitiveness.

Stakeholder Perceptions

The sustainability and practicality of seaweed-based bioplastic production in Pangkep Islands heavily depends on examining stakeholder perceptions. Various stakeholders including seaweed farmers and leaders and government officials and industry experts participated in this study to share their opinions about this emerging industrial sector. The overall perception of stakeholders demonstrates both positive expectations about gains from implementing bioplastics and doubts about practical implementation challenges that will determine future development directions in the seaweed-based bioplastic industry of the Pangkep Islands.

Numerous stakeholders from the Pangkep Islands felt confident about how seaweed-based bioplastic manufacturing would enhance their economic situation. People understood the prospects of earning new revenue streams at the same time as diversifying farmer income and establishing employment positions in the seaweed agricultural realm. Farmers who live in the area showed great enthusiasm about seaweed-processing to create high-value products that would boost their market positioning.

> *"If we can turn our seaweed into bioplastics, it could mean a better income for us. Right now, we only sell the raw seaweed, but bioplastic has a higher price and demand."*

Volume leaders from the community expressed their positive view about investing in bioplastic manufacturing because it would create new economic opportunities while minimizing traditional sea plant markets' volatile market prices. Both stakeholders and influential members actively support the initiative yet request enough backing through training programs and technological support alongside financial assistance. A number of stakeholders pointed out potential difficulties due to knowledge shortage and skill deficiencies that may create challenges for successful bioplastic implementation. Member of local farming communities acknowledge their lack of practical expertise to transform seaweed into bioplastic products that create manufacturing difficulties.

> *"We are used to farming and drying seaweed, but we do not have the skills to make bioplastics. It is something entirely new to us, and we would need proper training to learn how to do it."*

Multiple experts recognized that inadequate training initiatives alongside lack of capacity development would create obstacles for local individuals to learn and use new technology

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needed to produce bioplastics. The experts stated that governments along with private partners should implement educational initiatives and technical help programs to overcome these obstacles. The stakeholders gave varying responses about government backing for the development of seaweed-based bioplastic manufacturing. Stakeholders split into two groups about the helpfulness of government funding and policies to create necessary industry development.

> *"We hear about government programs to support local industries, but in reality, we often do not see any tangible assistance. If the government is serious about bioplastics, they need to show real commitment."*

The local entrepreneurs show skepticism because previous government initiatives never met their promises which created a lack of trust in these programs. The stakeholders advocated for both budget transparency and resource management accountability alongside defined policies that would enable sustainable bioplastic manufacturing. Bioplastic industry development in the Pangkep Islands received analysis regarding its environmental effects from stakeholders. The acceptance of seaweed-based bioplastics as better plastic alternatives to petroleum products leads to worries about expanding seaweed agriculture and processing operations.

> *"We need to ensure that increasing seaweed farming does not harm our coastal ecosystems. It is essential to balance economic growth with environmental protection."*

Successful sustainable practices in seaweed farming together with bioplastic creation must become mandatory because they help prevent environmental damage. Various stakeholders agreed that environmental assessment along with sustainable practice regulation needs immediate implementation. The market potential of seaweed-based bioplastics proved to be a significant point of concern among all stakeholders. Local stakeholders lack confidence about their ability to match established companies operating in the bioplastic industry despite increasing global demand for sustainable packaging solutions. The official commented on how this situation presents challenges according to government observations.

> *"We know there is demand for bioplastics, but competing in the international market is not easy. We need to focus on creating high-quality products that can meet international standards."*

Members of all stakeholder groups agreed that strategic marketing efforts together with certifications and partnership-building would enable market entry into international markets. The investigation demonstrates that additional scientific research must proceed together with product quality enhancement for bioplastics to achieve market competitiveness. The bioplastic industry in Pangkep requires different sectors including private industries, academia and government to work together because numerous stakeholders view this combination as essential for surmounting present obstacles. Different stakeholders understood the importance of teaming up to deliver needed financial backing as well as research opportunities and technological exchanges. Partnering became essential according to a local NGO representative as stated.

> *"We cannot do this alone. It requires a collaborative approach, involving the government, private sector, and communities to make it work."*

A multi-stakeholder method needs implementation to make seaweed-based bioplastics succeed as an industry. The use of different sectoral strengths will enable Pangkep to develop a sustainable bioplastic industry which supports local communities alongside achieving global environmental targets.

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The research about seaweed-based bioplastic manufacturing in Pangkep Islands investigates important knowledge voids regarding sustainable bioplastics together with local economic development. Research reveals that bioplastics have emerged as potential pollution solutions because seaweed stands out as an excellent raw material especially due to quick growth combined with reduced land consumption and minimal water usage (Elkaliny et al., 2024; Yong et al., 2024). Research on bioplastic manufacturing technologies and large-volume production mainly focuses on developed industrial areas. Research explores sea-based plastic manufacturing potential from socio-economic and environmental standpoints in local developing areas thus addressing deficiencies in small-scale communal bioplastic ventures.

This study confirms research evidence which demonstrates seaweed-based biological plastics serve as a financial opportunity for coastal communities by expanding their income streams. The current study examines how small-scale Pangkep Islands seaweed farmers can utilize bioplastic production to strengthen their economic situation whereas previous investigations focused on national or corporate business potential. Local stakeholders demonstrate enhanced understanding of sustainable economic diversification because they believe in the promising economic benefits (Aminpour et al., 2021; Hull et al., 2021). The research demonstrates that local bioplastic production decreases the vulnerability to seaweed export market fluctuations while creating new products which support community defense mechanisms.

Research on the technological developments in bioplastic production. minimally addresses the obstacles than small-scale producers experience when adopting such technologies. Research through this study examines concrete technological along with knowledge barriers which affect producers in Pangkep by showing they lack modern processing tools and need technical training. Technical challenges prevent developing areas from adopting new technologies according to the analysis of Hendrawan et al. (2024). This research develops a deeper understanding of these limiting factors by exploring them from the ground level while demonstrating the importance of specific intervention measures such as capacity development programs and government backing for these barriers' remedy.

Research studies show that social-cultural elements influence how people adopt sustainable practices according to Muwanga et al. (2024). The particular resistance toward implementing new farming approaches in Pangkep helps researchers understand better how cultural factors impact the adoption of bioplastics. This research showed that farmers in Pangkep hesitate to transform seaweed cultivation into bioplastic manufacturing because they lack trust combined with financial security concerns. The research adds new findings to previous about uniform resistance from farmers toward new agricultural methods. The study demonstrates why local communities need educational campaigns and participatory approaches to build acceptance for new technologies because they lack socio-cultural understanding.

Literature research confirms that government backing serves as a fundamental factor for sustainable industry development. A lack of research exists about how well government interventions work with rural communities that depend on seaweed farming. The research enhances knowledge about this field by showing that local community members maintain doubts toward public aid because they witness conflicting and untransparent government actions. The results validate Deguine et al. (2021) discovery that poor communication in policies and inadequate support services damage sustainable projects within developing regions. The research underscores how well-defined policies and improved transparency together with funding for local bioplastics projects would supply much needed solutions based on policy gaps in literature.

Studies reveal that seaweed-based bioplastics show excellent environmental advantages because they decompose easily while requiring less carbon emissions than petroleum-based

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plastics. The ramifications of seaweed cultivation growth on the environment receive less attention in discussions. The research introduces an advanced understanding by examining environmental risks such as excessive seaweed removal and the damaging of aquatic environments as mentioned by area environmental protestors during their interviews. The environmental impact of enormous-scale seaweed farming is supported by current research findings reported. The research merges theoretical views about environmental advantages with practical issues by integrating regional environmental concerns which stresses the relevance of sustainable harvesting approaches with environmental evaluations.

Current literature does not address the entry difficulties that face small-scale producers of bioplastics despite their increasing global market demand. The presented study examines how Pangkep producers confront obstacles when trying to fulfill international quality benchmarks and clearance requirements. The research discovery demonstrates that established bioplastic manufacturing competition exists together with a shortage of marketing expertise in the local producer sector. Research on developing nation bioplastics manufacturers now gets more extensive support through the discovery of market barriers by this study. Scientific research indicates that investing in specialized help for Pangkep market entry and brand identification and product testing requirements will substantially boost the competitive position of local seaweed bioplastics.

Conclusion

The research into seaweed-based bioplastic manufacturing in Pangkep Islands demonstrates that utilizing local seaweed resources creates substantial prospects to build sustainable economic growth. This research completes existing literature understanding through its analysis of community bioplastics because they support income generation while promoting environmentally friendly operations and plastic waste reduction. The study points out that production expansion faces major difficulties because of insufficient government backing and technological constraints and market regulations along with socio-cultural refusal and restricted access to technology. Research shows the necessity to create stakeholder collaboration through capacity development projects and policy framework development to break through production barriers so seaweed-based bioplastics can maximize their potential as economic and environmental sustainability assets.

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