

Academic-Industry Collaboration in Improving the Performance of Maritime Universities through Green Innovation as a Mediator

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Abstract

In today's era of open innovation, collaboration between universities and industry plays a crucial role in enhancing innovation systems and driving economic growth. This collaboration not only serves as a crucial driver for organizational development but also as a significant potential catalyst for green innovation. As a means for organizations to access external resources, university-industry collaboration helps companies quickly acquire necessary resources, provides access to cutting-edge research, and enhances their capacity to develop new technologies. It acts as a key mediator in strengthening the relationship between academic-industry collaboration and improved institutional performance. Through green innovation, the collaborative results can be implemented in the form of developing environmentally friendly technology, sustainable campus policies, and sustainability-based learning. Green innovation not only impacts the improvement of research quality and institutional reputation but also fosters ecological awareness and a culture of sustainability within the academic environment. The data type in this study is qualitative data, with data collection methods including literature review, interviews, observation, and documentation. The research findings indicate that the level of collaboration between maritime universities and the maritime industry significantly influences the creation of green innovation. Green innovation can boost university-industry collaboration in various forms, including graduate recruitment, joint research, academic exchanges, employe training, technical consulting, shared facilities, and patent licensing..

Keywords: Academic Collaboration, Maritime University Performance, Green Innovation, Industrialist Collaboration, Mediator.

Abstrak

Kolaborasi antara universitas dan industri memainkan peran penting dalam meningkatkan sistem inovasi serta mendorong pertumbuhan ekonomi. Kolaborasi ini tidak hanya menjadi pendorong penting bagi perkembangan organisasi, tetapi juga pendorong potensial yang signifikan bagi inovasi hijau. Sebagai sarana bagi organisasi untuk mengakses sumber daya eksternal, kolaborasi universitas-industri membantu perusahaan memperoleh sumber daya yang diperlukan dengan cepat, menyediakan akses ke penelitian mutakhir dan meningkatkan kapasitas mereka untuk mengembangkan teknologi baru. berperan sebagai mediator utama dalam memperkuat hubungan antara kolaborasi akademisi-industri dan peningkatan kinerja institusional. Melalui inovasi hijau, hasil kolaborasi dapat diimplementasikan dalam bentuk pengembangan teknologi ramah lingkungan, kebijakan kampus berkelanjutan, dan pembelajaran berbasis keberlanjutan. Inovasi hijau tidak hanya berdampak pada peningkatan kualitas riset dan reputasi lembaga, tetapi juga membangun kesadaran ekologis dan budaya keberlanjutan di lingkungan akademik. Jenis data dalam penelitian ini adalah jenis data kualitatif dengan metode pengambilan data studi literatur, wawancara, observasi dan dokumentasi. Penelitian ini memberikan manfaat bagi peningkatan kinerja Perguruan tinggi Maritim. Hasil penelitian menunjukkan bahwa tingkat kolaborasi antara perguruan tinggi maritim dan industri maritim memiliki pengaruh signifikan dalam mendorong terciptanya inovasi hijau. Inovasi hijau mampu memberikan dorongan kolaborasi universitas-industri yang dapat berupa berbagai bentuk, termasuk perekrutan lulusan, penelitian bersama, pertukaran akademis, pelatihan karyawan, konsultasi teknis, fasilitas bersama, dan lisensi paten.

Kata Kunci: *Kolaborasi Akademik, Kinerja Perguruan Tinggi, Inovasi hijau, Kolaborasi Industrialis, Mediator.*

INTRODUCTION

Maritime universities play a strategic role in producing superior, competitive, and adaptable human resources to technological developments and environmental sustainability issues in the maritime sector. However, the performance of maritime universities in Indonesia still faces various challenges, including limitations in producing applied research relevant to industry, minimal collaboration with the business sector, and a low level of sustainable innovation implementation in the three pillars of higher education activities. This condition leads to a gap between academic output and the practical needs of the maritime industry. Additionally, global pressure to implement sustainability and resource efficiency principles requires maritime universities to be able to transform by strengthening external collaboration and adopting green innovations as part of their institutional performance improvement strategy. The performance of maritime universities today faces various complex challenges, particularly in terms of increasing competitiveness and contributing to environmental sustainability. Many maritime universities still rely on conventional approaches that are less responsive to changing industry needs and global demands related to sustainability. The main problem faced is how to effectively improve the institution's performance by leveraging the synergy between academia and industry, particularly through the implementation of sustainable green innovation.

Empirical studies show that collaboration between academia and industry significantly contributes to improving the performance of higher education organizations by strengthening research, innovation, and curriculum relevance (Henry Etzkowitz & Loet Leydesdorff, 2000). The Triple Helix model explains that the synergistic interaction between universities, industry, and government is capable of accelerating the process of knowledge diffusion and driving the creation of sustainable innovation. In the context of maritime higher education institutions, such collaboration can facilitate the development of environmentally friendly technologies, improve energy efficiency, and implement green industry practices. Furthermore, various studies (Albort-Morant et al., 2018); (Chen Zewen & Liang Min, 2023) indicate that green innovation serves as an effective mediating variable in linking external collaboration with improved organizational performance, across economic, social, and environmental dimensions. Various studies have shown that collaboration between academia and industry has the potential to positively impact innovation and the performance of higher education institutions (El-Ferik & Al-Naser, 2021). Literature related to green innovation emphasizes the importance of implementing environmentally friendly innovations to support sustainable development, particularly in the maritime sector, which is highly vulnerable to environmental degradation (Bharathi, 2020); (Chakraborty et al., 2020); (Ching-Hsun Chang, 2011). Previous research notes that green innovation not only improves operational efficiency but also strengthens the reputation and competitiveness of universities in facing the challenges of the modern era.

Based on the study's findings, it can be assumed that the success of collaboration between academia and industry depends not only on the intensity of interaction, but also on the institution's ability to internalize sustainability values through green innovation. Maritime universities that can consistently develop green innovations have the potential to strengthen academic performance, institutional reputation, and contribution to sustainable development. Thus, green innovation is seen as a strategic mediating variable that connects academia-industry collaboration with improved university performance. Through this mechanism, collaboration is not only oriented toward utilizing external resources, but also serves as a means to create sustainable added value for the development of maritime institutions in Indonesia. The main argument in this research is that structured academic-industry collaboration can be a key driver

for maritime colleges to significantly improve their performance. Green innovation acts as a mediator connecting collaborative synergy with superior performance outcomes (H. Lin et al., 2014). By combining academic knowledge and practical industry needs through environmentally conscious innovation, universities can generate innovative and sustainable solutions, while also enhancing their relevance and contribution to the maritime and environmental world.

This study aims to examine the collaboration between academia and industry on the performance of maritime universities, with green innovation as a mediating variable. Specifically, this research aims to identify the extent to which collaboration between universities and industry can drive the creation of sustainable green innovation, and how this innovation contributes to improved institutional performance. The research findings are expected to contribute theoretically to the development of a sustainability-based academic-industry collaboration model. Additionally, this research aims to identify how green innovation mechanisms can strengthen collaborative relationships and drive improved institutional performance. It is hoped that the results of this study can provide strategic recommendations for university administrators and industry stakeholders to strengthen synergy and sustainability in the maritime sector.

METHOD

This research employs a qualitative approach with a case study design, aiming to deeply understand the collaboration process between academia and industry in enhancing the performance of maritime universities through the implementation of green innovation. The qualitative approach was chosen because it can contextually describe the dynamics of interaction, cooperation patterns, and factors influencing the success of collaboration within an environmental sustainability framework. The case study design is used to gain a holistic understanding of the collaboration phenomenon at one or more maritime universities that are the focus of the research.

Research Location and Subject

This research will be conducted at several maritime universities in Indonesia that have actively collaborated with the maritime industry, both in the form of applied research, joint curriculum development, and green technology innovation projects. The research subjects include three main groups:

1. Academics (lecturers, researchers, and heads of university research institutions),
2. Industry Representatives (research and development managers, or industry partners in collaborative programs), and
3. Policymakers (university or government institutions that facilitate academic-industry partnerships).

The selection of informants was done through purposive sampling, meaning it was based on the consideration that they have direct experience and a deep understanding of the collaboration process and the implementation of green innovation in the maritime university environment.

Data Source

The data used in this study consists of primary and secondary data, namely:

1. Primary data was obtained through in-depth interviews, participant observation, and focus group discussions (Creswell, 2009; Willig C., 2008). This data encompasses the perspectives, experiences, and strategies employed by universities and industry partners in achieving green collaboration and innovation.

2. Secondary data were obtained from cooperation documents between universities and industry, research and community service activity reports, university policies related to external collaboration, institutional performance reports, scientific publications, and official documents from relevant ministries or government agencies.

These two types of data are used complementarily to build a complete understanding of the phenomenon being studied.

Data Collection Techniques

The data collection process was carried out through the following stages:

1. In-depth Interviews – conducted semi-structured with key informants to explore their experiences and perceptions regarding academic-industry collaboration practices, the obstacles they face, and the role of green innovation in improving university performance.
2. Participant Observation – conducted in the university environment and with industry partners to directly understand the dynamics of cooperation, communication patterns, and the application of green innovation.
3. Documentation – collecting various secondary data such as MoUs, cooperation reports, campus policies, and institutional performance data to strengthen the results of interviews and observations
4. Focus Group Discussion (FGD) – conducted with several informants from both sides to gain understanding and clarification regarding the initial research findings.

Research Stages

This research will be conducted through several systematic stages, namely:

1. Preparation Stage, including literature study, formulating the research focus, determining location and informants, and preparing interview guidelines.
2. Field Data Collection Stage, including conducting interviews, observations, and documentation at the research location.
3. Data Reduction and Coding Stage, which is the process of grouping and filtering data according to main themes such as forms of collaboration, green innovation strategies, and their impact on university performance.
4. Data Analysis Stage, conducted inductively using thematic analysis methods to identify patterns of relationships between variables and find the substantive meaning of the research results.
5. Conclusion and Verification Stage, which is formulating the main findings and testing the validity of the data through source, method, and time triangulation.

Data Validity

The validity of the data is ensured through the four criteria of qualitative research credibility according to (Taylor & Bodgan, 2016), namely credibility, transferability, dependability, and confirmability. Researchers ensured credibility through adequate field engagement, validation of interview results with informants, and transparent documentation of the analysis process.

1. Credibility: Credibility indicates the level of trust in the truth of the research data and findings. In this study, credibility was maintained by ensuring that the data obtained truly reflected the reality of academia-industry collaboration and the implementation of green innovation in maritime universities.
2. Transferability: Transferability relates to the extent to which research findings can be applied or transferred to other contexts with similar characteristics. In this study, transferability was achieved by providing a detailed contextual description (thick description) of the academic-

industry collaboration process, the characteristics of maritime universities, and the forms of green innovation implementation found.

3. **Dependability:** Dependability refers to the consistency and stability of research data over time. To ensure dependability, this study applied a systematic documentation procedure to all stages of the research, from data collection to analysis and interpretation of results.
4. **Confirmability:** Confirmability relates to the extent to which research findings are free from researcher bias and truly reflect the views and experiences of the informants. In this study, confirmability was maintained through the application of the principle of reflective objectivity, where the researcher sought to distance themselves from personal assumptions and not impose subjective interpretations.

Overall, the four criteria of qualitative validity – credibility, transferability, dependability, and confirmability – have been systematically maintained in this study. The application of these principles ensures that the research findings on academic-industry collaboration and the role of green innovation as a mediator have high scientific validity, are methodologically sound, and contribute theoretically and practically to the sustainable development of maritime universities.

RESULTS AND DISCUSSION

Result

The research results indicate that collaboration between academics and industry in maritime universities takes various forms of activities, including academic, research, and community service initiatives. The most dominant forms of collaboration include:

1. Joint research in the fields of marine technology, energy efficiency, and maritime safety;
2. Internship and competency training programs, connecting students with the shipping industry, marine logistics, and renewable energy; and
3. Industry-based curriculum development, aligning graduates' competency needs with technological advancements and international maritime regulations.

From in-depth interviews with faculty leaders, lecturers, and industry partners, it was found that the collaboration was not only formal through a memorandum of understanding (MoU), but also functional in the form of active involvement from both parties in the implementation of research and innovation projects. Effective collaboration is characterized by open communication, clarity of shared goals, and transparent coordination mechanisms. However, some universities still face challenges in terms of the sustainability of cooperation and the gap in expectations between the academic and industrial worlds.

Mediator of Collaboration and Performance Improvement

The research findings indicate that green innovation plays a significant mediating role in the relationship between academia-industry collaboration and improved performance of maritime universities. Based on qualitative data obtained from interviews and documentation, green innovation is reflected in three main aspects:

1. Environmentally friendly technological innovation, such as the development of ship waste treatment systems and fuel efficiency;
2. Managerial innovation, including green campus policies and sustainable energy management; and
3. Academic innovation, such as the integration of sustainability issues into the curriculum and student research.

Maritime universities that actively collaborate with industry show a greater tendency to produce applicable green innovations. This is due to the two-way flow of knowledge between the academic and industrial worlds, which allows universities to gain empirical insights into

real-world needs and challenges. Thus, green innovation becomes a strategic bridge connecting academic-industry synergy with improved institutional performance.

The Impact of Academic-Industry Collaboration and Green Innovation on the Performance of Maritime Universities

Analysis of the research results indicates that academic-industry collaboration integrated with green innovation has a positive impact on various dimensions of maritime university performance. Performance improvement can be seen from:

1. Academic dimension, which is the improvement of research quality and scientific publications relevant to maritime sustainability issues.
2. Institutional dimension, namely increasing institutional capacity through the establishment of a green innovation research center, strengthening international partnership networks, and improving study program accreditation.
3. Environmental dimension, which is the implementation of energy efficiency systems, campus waste reduction, and increasing academic community awareness of sustainability.
4. Reputation and networking dimension, where universities actively innovating green technologies tend to gain wider recognition from industry partners and government agencies.

This result reinforces the view that the success of academic-industry collaboration is not only measured by the quantity of partnerships undertaken, but also by the quality of green innovations produced and the extent to which these innovation outcomes impact the sustainability and competitiveness of the institution.

Supporting and Inhibiting Factors in the Implementation of Academic-Industry Collaboration and Green Innovation

Based on field findings, there are several factors that influence the effectiveness of implementing academic-industry collaboration and green innovation in maritime universities. Supporting factors include:

1. Institutional policy support, such as the existence of a green research roadmap and strategic partnership programs.
2. Availability of qualified human resources, including lecturers and researchers, with expertise in sustainable maritime fields.
3. Active involvement of industry stakeholders, especially in providing access to technology and testing facilities.

Meanwhile, the identified inhibiting factors include:

1. The difference in orientation between the academic and industrial worlds, where academics are focused on long-term research while industry is focused on short-term profits.
2. Limited research funding, which often hinders the development and commercialization of green innovations.
3. The lack of a monitoring and evaluation system for the collaboration, resulting in some collaborations proceeding without clear measurement of achievements.

These constraints highlight the need for strengthening targeted and sustainable collaborative governance so that academic-industry synergy can make an optimal contribution to improving institutional performance.

Discussion

Academic-Industry Collaboration as a Driver of Innovation and Performance Improvement

The research findings indicate that collaboration between academia and industry within the maritime higher education environment plays a fundamental role in driving institutional performance improvement. This collaboration serves as a means of knowledge transfer,

technology exchange, and human resource development relevant to the needs of the maritime workforce. The forms of cooperation found include joint research, industry-based curriculum development, student work practice implementation, and technology innovation projects.

These findings align with the Triple Helix concept proposed by (Henry Etzkowitz & Loet Leydesdorff, 2000) where the interaction between universities, industry, and government serves as the main catalyst for innovation and knowledge-based economic growth. In this context, maritime colleges play a role not only as educational institutions but also as agents of innovation, providing solutions to challenges in the maritime industry, such as energy efficiency, navigation safety, and marine environmental management. Effective collaboration has proven to strengthen academic relevance, improve research quality, and expand strategic partnership networks with the industrial sector.

The Role of Green Innovation as a Mediator in the Relationship between Collaboration and Performance

The research findings confirm that green innovation serves as an important mediating variable in strengthening the relationship between academia-industry collaboration and improved university performance. Intensive and sustained collaboration has been proven to spark the emergence of various forms of green innovation, both in the technological, managerial, and academic realms. Some maritime universities that were the subject of research have developed renewable energy-based research programs, ship waste management systems, and the implementation of fuel efficiency technology in training laboratories.

These findings support the results of (Chen et al., 2018) and (Albort-Morant et al., 2018), which indicate that green innovation is an important mechanism for linking external collaboration with improved organizational performance. In the context of higher education, green innovation not only produces applicable research outputs but also builds an organizational culture oriented toward sustainability. Thus, green innovation serves as a bridge that transforms the outcomes of academic-industry collaboration into tangible improvements in academic reputation, resource efficiency, and contributions to sustainable development.

The Impact of Academic-Industry Collaboration and Green Innovation on the Performance of Maritime Universities

Based on the analysis of field findings, the improved performance of maritime higher education institutions involved in industry collaboration and implementing green innovations is evident in several key aspects:

1. Academic and Research Performance: increased through the number of indexed publications, patent development, and applied research relevant to the needs of the maritime industry.
2. Environmental and Social Performance: seen in the implementation of green campus policies, energy efficiency, and waste and emission management within the university environment.
3. Partnership Performance and Institutional Reputation: higher education institutions actively collaborating with industry have a better reputation in the eyes of partners and stakeholders because they are considered adaptive, responsive, and focused on real solutions.

This shows that synergy between external collaboration and internal innovation can be an effective strategy to strengthen the competitiveness of maritime universities, both nationally and internationally. In other words, green innovation is not only an environmental instrument, but also a strategic tool for institutional strengthening.

Factors Supporting and Inhibiting Academic-Industry Collaboration and Green Innovation

The research findings also identified a number of factors that influence the success of academic-industry collaboration and the implementation of green innovation. The main supporting factors include:

1. Commitment from institutional leadership in supporting cross-sector collaboration,
2. Campus policies oriented toward sustainability,
3. Access to research funding, and
4. An extensive network of industry partnerships.

However, there are also inhibiting factors that need to be considered, such as differences in orientation between the academic and industrial worlds, a lack of cross-unit coordination within universities, and limited human resource capacity in green applied research. These barriers indicate that the success of collaboration is not solely determined by the existence of formal partnerships, but also by the effectiveness of collaboration management and the integration of a sustainability vision throughout the institutional processes.

Theoretical and Practical Implications of the Research

Theoretically, the results of this study strengthen the argument that academic-industry collaboration is an important determinant in the formation of a sustainable innovation ecosystem in higher education, as explained in the Triple Helix theory and the concept of Open Innovation. Green innovation has proven to be a key mediator that transforms the outcomes of external interactions into improved internal performance of maritime colleges.

Practically, this research provides implications for university administrators to strengthen collaboration strategies oriented toward sustainability. Maritime universities need to develop a "green collaboration framework" policy, establish a special unit to manage green innovation, and enhance the capacity of lecturers and researchers to conduct applied research that directly impacts the industrial sector. Meanwhile, for the industrial world, this research confirms the importance of sustainable partnerships with universities to accelerate green technology innovation and enhance global competitiveness.

CONCLUSION

Collaboration between academia and industry plays a strategic role in improving the performance of maritime universities, both in academic, institutional, and environmental aspects. This collaboration enables knowledge transfer, technology exchange, and increased relevance of curriculum and research to the evolving needs of the maritime industry. Effective synergy creates a mutually beneficial relationship between universities as knowledge producers and industry as technology implementers.

Additionally, this research proves that green innovation serves as a key mediator in strengthening the relationship between academia-industry collaboration and improved institutional performance. Through green innovation, the results of the collaboration can be implemented in the form of developing environmentally friendly technology, sustainable campus policies, and sustainability-based learning. Green innovation not only impacts the improvement of research quality and institutional reputation but also builds ecological awareness and a culture of sustainability within the academic environment.

The research findings also indicate that the success of Academic-Industry Collaboration and Green Innovation is significantly influenced by institutional support, the university's strategic policies, and the active commitment of industry partners. Higher education institutions with a clear collaborative governance system, competent human resources, and a focus on sustainability have proven more successful in leveraging collaboration to drive superior performance. In the future, further research is needed on strengthening sustainability-based

Maritime Research Centers, one of which is by establishing the Center for Maritime Green Innovation as a platform for academic-industrial collaboration.

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