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## Digital Transformation for Carbon Emission Management as a Strategic Driver for Scope 3 Emission Accountability in the Energy Sector

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### **Abstract:**

*According to the acceleration of Indonesia's energy transition and carbon pricing policies, the role of digital transformation in managing carbon emissions is important, especially in addressing Scope 3 emissions, which are still the most complex and indirect (World Bank, 2024). This study explores how the Greenomina platform is implemented by PT Pertamina (Persero) acts as a digitally enabled mechanism for Scope 3 emissions tracking, management, and stakeholder accountability. By applying two frameworks, which are the Digital Transformation Canvas (DTC) and Triple Layer Business Model Canvas (TLBMC), this study identifies critical drivers of ESG integration, employee engagement, and carbon data transparency in PT Pertamina (Persero)'s internal systems (Elia et al., 2024). The findings highlight the transformative potential of corporate innovation in driving to decarbonization strategies while also highlighting persistent barriers such as limited technological infrastructure and digital literacy gaps among internal employee. The implementation of Greenomina has already resulted in some measurable improvements, especially in internal emission data traceability, enhanced ESG reporting, and employee participation in a voluntary of carbon footprint management. This study contributes to the growing literature on strategic digitalization for environmental sustainability, offering practical insights for other companies in carbon-intensive sectors, and the pioneer of accountability in carbon emission management. This study aims to become an acceleration of the carbon footprint management for employees, especially in Energy Sector and projected to be implemented by State-Owned Enterprises or Badan Usaha Milik Negara (BUMN) ecosystems in Indonesia.*

**Keywords:** Decarbonization, Emission Management, Energy Transition, Energy Efficiency, Digitalization, Sustainability, Digital Transformation

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## 1. Introduction

Organizations are increasingly responsible to the whole spectrums regarding to greenhouse gas (GHG) emissions, including the Scope 3, which consists of an indirect emissions that is resulting from value chain activities including travel, logistics, procurement, and product use. This makes change mitigating a worldwide imperative. The GHG Protocol states that although Scope 3 usually shows the highest share of a

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company's total emissions, limited data access and external dependencies make it most difficult to quantify and control (Callahan et al., 2023). These complexity highlight the pressing need of creative solutions transcending traditional reporting structures.

Digital transformation has significantly improves carbon traceability and transparency. The systems in a Corporate sustainability are progressively using some variables like blockchain, cloud platforms, IoT, and machine learning technologies to assist to emission reduction strategies, also automate data collecting, and increase carbon accounting accuracy (Elia et al., 2024). Stakeholder accountability and real-time GHG emissions tracking are should be enabled via digital platforms, which are critical for managing Scope 3 operations. In the high-emission industries such as oil and gas, the transition to data-driven platforms is deliberate move towards more measured and verifiable sustainable practices (Biswas et al., 2025).

The government in Indonesia, where the fossil fuels still as the majority of the country's energy mix, it has already initiated that carbon pricing programs, such as the national Emissions Trading System (ETS) and also voluntary carbon markets mechanisms. State-owned businesses like PT Pertamina (Persero) can lead decarbonization initiatives through innovation because of these policies. One example of how digital tools can aligned with internal emissions data with international ESG standards and broader national climate commitments is Pertamina's creation of Greenomina, a digital carbon management platform (World Bank, 2024). Greenomina converts carbon footprints into certified credits that can be traded through the IDX Carbon, allowing internal employees and Greenomina members to calculate and offset emissions from activities like business travel.

There are three (3) Research Questions of this study:

- (1) How does Greenomina platform contributes to Scope 3 carbon emission tracking and management within PT Pertamina (Persero)?  
This explores platform's practical roles in enhancing an accountability for indirect emissions.
- (2) What are the key organizational enablers and challenges in implementing a digital carbon emission management tools especially in a state-owned enterprise?  
This will investigates an internal factors such as leadership, employee engagement, and digital readiness.
- (3) How does Greenomina influence the ESG integration, employee behaviors, and the sustainability cultures in the context of Indonesia's energy transition?  
This examines the platform's broader impacts to the environmental governance and a strategic transformation.

This study will examines the Greenomina platform as a strategic digital transformation initiative to drives the Scope 3 emission accountability. By applying two analytical lenses from two frameworks like the Digital Transformation Canvas (DTC) and the Triple Layer Business Model Canvas (TLBMC), this research aims to explore how digitalization will supports energy companies in alignment in the business models together with sustainability objectives (Pigneur et al., 2015). These frameworks will allow for a multi-dimensional analysis of Greenomina's role in

integrating economic, environmental, and also social value, while identifying to potential pitfalls such as resistance to organizational change, technological limitations, and the low digital maturity (Elia et al., 2024).

This research contributes in the growing literature on the decarbonization and corporate digital innovation by highlighting especially in the case of Indonesia's energy sector. It offers practical insights in how strategic digital tools can accelerate ESG integration and makes some improvements on accountability for hard-to-track emissions becomes easier-to-track. As global stakeholders increasingly demand growing sustainability disclosures and tangible climate actions, to the role of digital carbon platforms like Greenomina becomes not only a technical solution but also as strategic imperative (Dane M. Christensen, 2022).

## **2. Theoretical Background**

The integration of a digital technologies into the carbon emission management has emerged as a strategic necessities for some companies seeking to meets sustainability targets, particularly in emission-intensive industries such as the oil and gas. One of the primary theoretical lenses underpinns this research is the Triple Layer Business Model Canvas (TLBMC) (Pigneur et al., 2015). Unlike the traditionals Business Model Canvas (BMC), the TLBMC incorporating the three (3) dimensions: economic, environmental, and social layers. These layers provide the more holistic framework for evaluating business innovations such as Greenomina, allowing the organization to assess a value creation not only from a financial standpoint but also in terms of the environmental sustainability and the stakeholder impact. This model is basically relevant to mapping and visualizing Pertamina's decarbonization initiatives, especially in managing to the Scope 3 emissions.

Another some critical theoreticals foundations as Digital Transformation Canvas (DTC), that providing any of structural approaches for implements some of digital changes consists of the four (4) key pillars, such as: strategy, operations, value, and also pitfalls (Elia et al., 2024). The canvas will enables a details assessment of how the digital infrastructures, such as cloud platforms, emission tracking tools, and also automated reporting systems, can be aligned with the organizational strategy to enhance an ESG performances. The DTC framework will supports the evaluation of Greenomina not merely as the technological platform but also as a driver for systemic changes within the PT Pertamina (Persero), includes the development of an internal digital capabilities and also cultural readiness for the sustainability for reporting.

In addition, this research evaluate from the GHG Protocol the Scope 3 Standards, which provides guidelines to identifying and calculating an indirect emissions across the value chains. Scope 3 emissions oftens account to more than 70% of a company's total emissions footprint and notoriously very difficult to manage due to their dependency on third parties for example suppliers, logistics partners, and also service providers (Callahan et al., 2023). By embedding the digital solutions into Scope 3 reporting and an accountability processes, the companies can improves transparency,

comparability, and also data traceability's elements that are very crucial for credibility in sustainability disclosures and in the carbon markets.

**Table 1. Framework Alignment to GHG Scope 3 Standard**

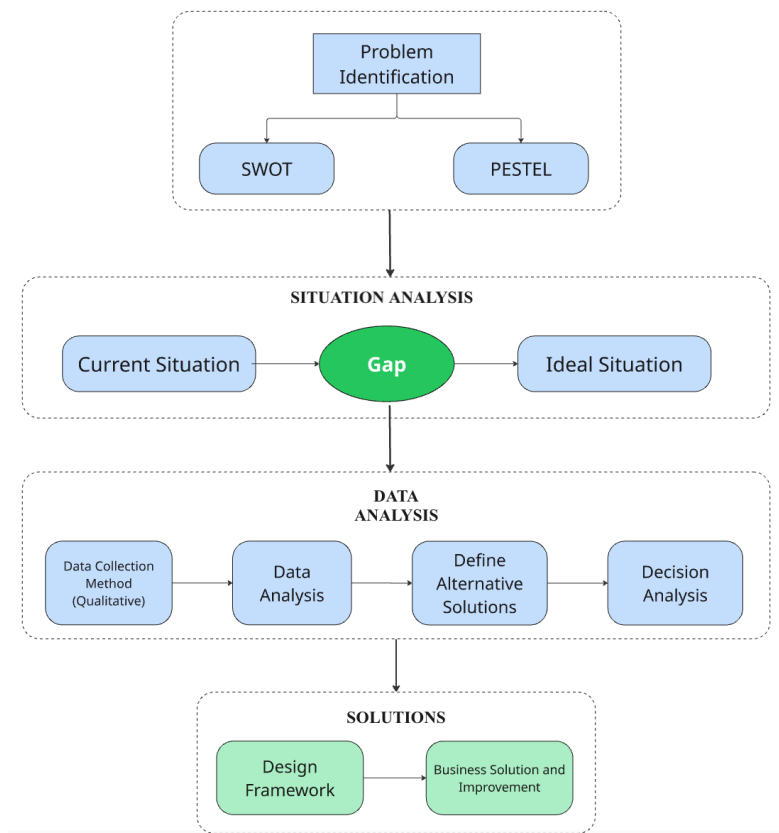
| Framework   | Core Focus  | Application in This Study  | Alignment to GHG Scope 3 Standards  |
|---|---|--|---|
| <b>Triple Layer Business Model Canvas (TLBMC)</b> | Economic, Environmental, Social value                           | Used to assess Greenomina's multi-dimensional value creation (for example: Scope 3 tracking, employee engagement, cost-saving potential) | Guides the identification of relevant emission categories and supports the evaluation of Greenomina's Scope 3 focus which are business trip, emission of transportations, and events. |
| <b>Digital Transformation Canvas (DTC)</b>        | Strategy, operations, value, and risk in digital transformation | Frames the analysis of Greeno(Pigneur et al., 2015)mina's development, implementation, and internal integration process                  | Provides reference for indirect emission classification in digital integration context, particularly for risk mitigation in cybersecurity.  |

Source: 2025 Author's Research

The integrations of Triple Layer Business Model Canvas (TLBMC) and the Digital Transformation Canvas (DTC) to this study will provide the comprehensive theoretical foundation to evaluates the Greenomina platform from both sustainability and also digital transformation perspectives. According to TLBMC framework, it enables a multi-dimensional analysis of the Greenomina's value creations across the economic, environmental, and social domains, particularly in tracking to Scope 3 emissions, it also accelerating the employee engagements, and identifying cost-saving opportunities (Pigneur et al., 2015). Meanwhile, DTC also offers strategics lens to assessing how Greenomina's development, operationalized, and integration in the PT Pertamina (Persero)'s internal systems to supports digital transformation goals (Elia et al., 2024). Although the GHG Protocol Scope 3 Standard is not used as the core theoretical framework, it is provides essential guidance for classifying an indirect emissions such as business travel, logistics, and event-related activities. This alignments ensures that the study's design is compatibles with internationally recognized reporting standards and to strengthens its practical relevance for corporate ESG and a carbon disclosure efforts (Callahan et al., 2023). Together, these frameworks ensure the research both in conceptually grounded and aligned with Indonesia's broaders decarbonization and ESG integration objectives.

Finally, the concept of the digital-environmental convergence reinforces to the theoretical rationales for this research. As it emphasized to the OECD. (OECD, 2024), the convergences between digital transformation and also environmental sustainability (often refers as the "twin transition") creates new pathways for achieving to net-zero emissions through an intelligent systems. These includes real-time monitoring, blockchain-enabled carbon traceability, and the AI-driven energy optimizations. By leveraging the convergences, companies like PT Pertamina (Persero) can strategically positioning themselves not only meet regulatory requirements but also to strengthening their competitive advantage in a global energy markets.

## Research Framework



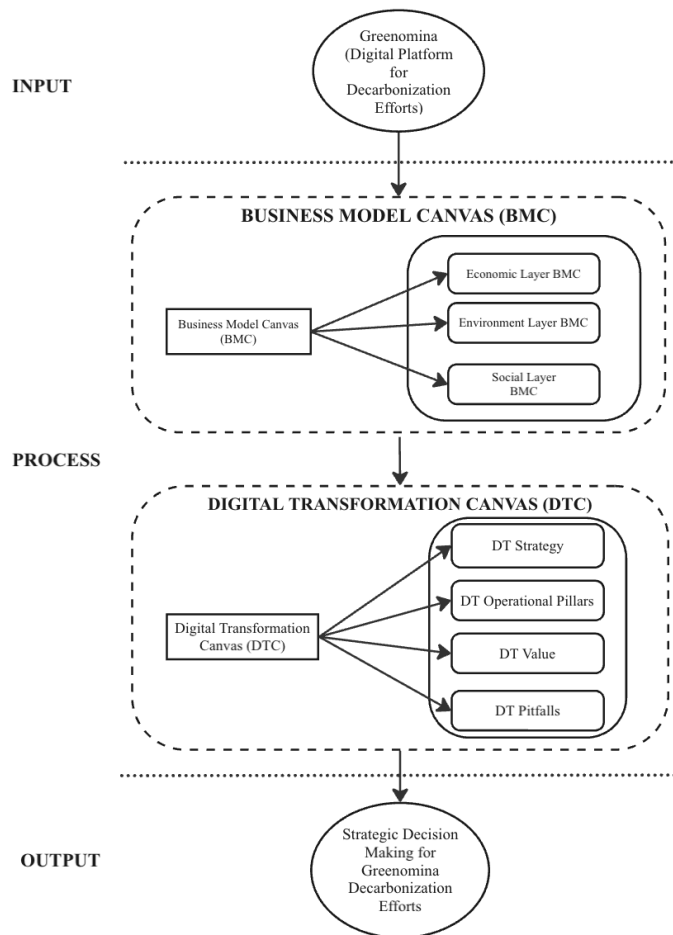
**Figure 1. Research Framework**  
Source: Author's Research

The research framework is presented in the image illustration that a structured approach to problem-solving in a strategic business analysis, especially in the context of digital transformation and the carbon emission management. The framework started with problem identification, which supported by two diagnostics tools: SWOT analysis to evaluates the internal strengths and weaknesses, and PESTEL analysis to examines the external macro-environment. These tool feeds to the situation analysis phase, where is the gap between the current and ideal situation determined. Identifying this gap is very important in the understanding misalignment between an existing operational conditions and a desired of any sustainability outcomes, especially for complex challenges like Scope 3 emission accountability (CDP, 2022).

Once the gap is already identified, the framework will transitions into the data analysis stage, which utilizes a qualitative data collection methods for example like interviews or document reviews. These inputs undergoing an analysis to uncover actionable insights, followed by the definition of alternative solutions and by the decision analysis phases to selected the most viable strategic direction. The final component of the solution development, which is consists of crafting any design framework and also

recommending some business solutions or improvements. This structured, iterative process will ensure that recommendations are grounded to both empirical insights and also strategic logic. It will support the informed decision-making aligned with sustainability goals, makes it especially suitable for an energy company in pursuing a digital transformation for the environmental accountability (OECD, 2024).

### Conceptual Framework



**Figure 2. Conceptual Framework**

Source: Author's Research

The conceptual framework is illustrated in the diagram provides a structured pathway to understand how Greenomina, PT Pertamina (Persero)'s digital platform, facilitates strategic decision-making in decarbonization through a dual-framework analysis. At the input level, Greenomina is evaluated using the Triple Layer Business Model Canvas (TLBMC), which dissects the business model into three interdependent layers: economic, environmental, and social. This approach ensures that decarbonization efforts are not only financially viable but also environmentally sustainable and socially inclusive. The economic layer analyzes value creation mechanisms such as carbon credit monetization; the environmental layer addresses Scope 3 emissions and

lifecycle assessment; and the social layer emphasizes employee engagement and stakeholder inclusion (Lüdeke-Freund et al., 2018). This holistic view helps identify gaps in current business practices and supports more responsible and circular value propositions.

Moving into the process phase, the framework transitions into the Digital Transformation Canvas (DTC), which serves as a practical tool to evaluate the operationalization of Greenomina. This includes analyzing digital strategy, operational pillars such as system architecture or AI integration, value generation from digital interventions, and potential pitfalls such as digital resistance or data governance issues. The combination of TLBMC and DTC enables a comprehensive transformation model that links sustainable business design with actionable digitalization processes. The output is a strategic roadmap for Greenomina's decarbonization journey, enhancing Pertamina's capacity to align with ESG goals while leveraging data-driven innovation. This integrated approach supports not only digital maturity but also institutional readiness for long-term carbon accountability in Indonesia's energy sector (World Economic Forum, 2025).

### **3. Methodology**

This research adopts the qualitative approach to investigate how digital transformation enables carbon emission management, in particular of the context of the Scope 3 accountability. Data collection was carried out through in-depth interviews which involved twelve (12) key stakeholders who directly involved in or familiar with the design, implementation, and also the utilization of the Greenomina platform. The participants included representatives from Pertamina's sustainability division, digital transformation teams, operational departments, and also the strategic partners. The interviews were conducted to explore any perceptions, challenges, and the successful factors for any deployments of Greenomina as the carbon footprint emission management tool. The primary data collection complemented by any of secondary data sources, includes internal reports, ESG disclosures, policy documents, and corporate presentations. This is a triangulated approach to enhance both the validity and reliability of the findings, in line with a qualitative research method best practices (Creswell & Poth, 2018).

The data were analyzed by using a thematic coding analysis, following the structured six-phase method. These phases include familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining, naming themes, and also producing the report (Braun & Clarke, 2006). Instead of using specialized qualitative software, the analysis was conducted using manual coding in Microsoft Excel, which allowed any systematic classification, sorting, and filtering of the stakeholder's responses across various themes. Manual Excel-based analysis, though more time-intensive, remains valid and also a transparent method for organizing qualitative data, especially in a small to medium sample about the research contexts (O'Connor & Joffe, 2020).

To ensure the analytical rigor, this study is applied two (2) theoretical frameworks: a Triple Layer Business Model Canvas (TLBMC) and also the Digital Transformation Canvas (DTC). These frameworks is supported the classification and interpretation of some qualitative insights across the multiple sustainability dimensions about economic, environmental, social, and also in digital. The combined application of these frameworks provided any structured lens through which to evaluate Greenomina's alignment with Pertamina's decarbonization goals and a national carbon pricing policies. Ethical approvals to the study was secured through the university's academic ethics committee. All participants are gave informed consent, and their identities were keep anonymized to uphold research ethics and the confidentiality standards. This methodology provides a high quality and context-sensitive design to explore the digital innovation and the Scope 3 accountability in Indonesia, especially in energy sector.

The Limitations of this research are: Data Accessibility, due to any confidentiality and availability of issues, access to reliable and comprehensive data may be restricted, affecting analysis accuracy. Also, The research focuses only at PT Pertamina (Persero), it may limits the applicability of findings to other companies or industries. Subjectivity in the Qualitative Data in this research will be interpreted by the stakeholder interviews and policy impacts based on subjectivity of qualitative assessment.

#### **4. Empirical Findings/Result**

##### **Triple Layer Business Model Canvas (TLBMC)**

An essential part of the framework that builds upon the traditional company Model Canvas is the Triple Layered Business Model Canvas (TLBMC), which incorporates not only the economic but also environmental and social aspect of a business model. This approach is particularly relevant to PT Pertamina (Persero)'s Greenomina program, which blending environmental initiatives with digital innovation. By documenting to how Greenomina creates value in economic from carbon credit monetization and operational efficiency, while also simultaneously addressing environmental goals like Scope 3 emission reduction and social goals like employee engagement and community awareness, the TLBMC make it possible to implementing a thorough evaluation by the company's impact. The framework giving a comprehensive picture of how Greenomina fits with the company's sustainability goals and national carbon emission reduction initiatives by looking to economic, environmental, and social layers.

The framework is very suitable for the study because it facilitate a structured analysis of how Greenomina's digital platform supports PT Pertamina (Persero)'s decarbonization strategy from various perspectives. The economic layer focus on how Greenomina creates financial value through digital transformation; the environmental layer to evaluates its direct contribution to carbon reduction and ESG compliance; and also the social layer investigates how it improve a culture of sustainability within the



company and among to the stakeholders. This study use the TLBMC in interviews and qualitative analysis show that Greenomina's success is measured not only by financial returns but also by the ability to produce positive social and environmental outcomes, makes it a strategic choice for promoting long-term sustainable development in Indonesia's energy sector.

**Table 2. Economic Layer Business Model Canvas**

| Economic Layer Business Model Canvas |                        |   |   |
|--------------------------------------|------------------------|---|---|
| No                                   | BMC Element            | Greenomina Case Description                       | Analysis  |
| 1                                    | Key Partners           | 1. Academic Institutions                          | Strategic alliances with knowledge and tech partners enhance platform legitimacy and scalability. |
|                                      |                        | 2. Technology Provider                            |   |
|                                      |                        | 3. Regulators                                     |   |
| 2                                    | Key Activities         | 1. Automation in Emission Management              | Core activities ensure the platform remains relevant to policy and ESG demands.                   |
|                                      |                        | 2. Emission Scope 3 Reporting                     |   |
|                                      |                        | 3. R&D and Policy Development                     |   |
|                                      |                        | 4. Data Optimization                              |   |
| 3                                    | Key Resources          | 1. Human Resources (Tech Talent)                  | Key enablers include digital infrastructure and skilled human capital.                            |
|                                      |                        | 2. Analytics and Processing Tools                 |   |
|                                      |                        | 3. Mobile Access                                  |   |
|                                      |                        | 4. Cloud Infrastructure                           |   |
| 4                                    | Value Propositions     | 1. Scope 3 Decision-Making                        | Platform offers strategic value for ESG alignment and Scope 3 accountability.                     |
|                                      |                        | 2. Academic-Business Strategy Integration         |   |
|                                      |                        | 3. Focus on Decarbonization                       |   |
| 5                                    | Customer Relationships | 1. Internal Collaboration                         | Multi-stakeholder collaboration strengthens ownership and long-term adoption.                     |
|                                      |                        | 2. Tech Provider Co-Design                        |   |
|                                      |                        | 3. Long-Term Relations with Academia & Regulators |   |
| 6                                    | Channels               | 1. Greenomina Web and Mobile App                  | Channel integration allows seamless access and user adoption.                                     |
|                                      |                        | 2. My Pertamina App                               |   |
| 7                                    | Customer Segments      | 1. Internal Employees                             | Primarily targets internal transformation; future scalability to national ecosystems.             |
|                                      |                        | 2. BUMN Ecosystem (future)                        |   |
| 8                                    | Cost Structure         | 1. R&D and Development Costs                      | High initial investment is justified by long-term efficiency and sustainability.                  |
|                                      |                        | 2. Operational Costs                              |   |
|                                      |                        | 3. System Budget Allocation                       |   |
| 9                                    | Revenue Streams        | 1. Carbon Trading Revenue                         | Revenue potential lies in carbon market integration and ESG monetization.                         |
|                                      |                        | 2. Future Monetization Opportunities              |   |

Source: 2025 Author's Research

The economic layer on this Greenomina Business Model Canvas demonstrates of how PT Pertamina (Persero) strategically integrating digital innovation with carbon accountability to drive the decarbonization. The platform's value proposition enabling real-time Scope 3 emission tracking and providing decision-making support for a sustainability targets, in particular it line with Indonesia's net-zero 2060 commitment. Key partners such as the academic institutions, technology providers, and also regulatory stakeholders are instrumental in the developing and legitimizing a platform. Central activities that include automation of emission management, R&D, and policy engagement, all is supported by digital infrastructure and skilled human capital. The internal employee as a base functions in the initial customer segment, with future scalability to the wider State-Owned Enterprises (SOEs) or *Badan Usaha*

*Milik Negara (BUMN)* ecosystem is anticipated. Distribution channels via the Greenomina and MyPertamina applications ensuring an accessibility across departments. Although the initiative that involves substantial upfront investment for the development, training, and system integration, it also offers the long-term economic returns through an improved operational efficiency, potential carbon credit monetization, and also enhanced ESG reputations. The sustainable of business models should embed a long-term environmental and economic values creation into the core of an innovation practices. The Greenomina platform's business model reflected this dual value proposition, demonstrating on how economic viability and environmental accountability can also coexist within the digitally enabled in a sustainability strategy (Lüdeke-Freund et al., 2018).

**Table 3. Environment Layer Business Model Canvas**

| Environment Layer Business Model Canvas |                          |   |  |
|---|--------------------------|---|--|
| No.                                     | BMC Element              | Greenomina Case Description                                 | Analysis   |
| 1                                       | Supplies and Outsourcing | 1. Academic Institutions                                    | Collaborating with experts and regulators ensures scientific and policy alignment. |
|   |                          | 2. Regulatory Stakeholders                                  |  |
| 2                                       | Production               | Greenomina digital platform for Scope 3 emission management | Platform acts as digital infrastructure for measuring and managing emissions.      |
| 3                                       | Materials                | 1. Data   | Digital materials minimize resource use and improve data scalability.              |
|   |                          | 2. Cloud Computing  |  |
|   |                          | 3. Server   |  |
| 4                                       | Functional Value         | 1. Support Pertamina's Net Zero 2060 Goals                  | Provides long-term carbon accountability and ESG decision support.                 |
|   |                          | 2. Build carbon awareness                                   |  |
| 5                                       | Distribution             | Distributed to all Pertamina employees                      | Inclusive rollout to employees maximizes behavioral impact.                        |
| 6                                       | Use Phase                | 1. Promote sustainability behavior                          | Encourages emission ownership among individuals through digital nudging.           |
|   |                          | 2. Track & convert output to IDX Carbon                     |  |
| 7                                       | End-of-Life              | Continuous improvement in decarbonization culture           | Sustains emission reductions via ongoing platform upgrades.                        |
| 8                                       | Environmental Impacts    | 1. Calculate and reduce Scope 3 emissions                   | Greenomina quantifies indirect emissions often excluded from reports.              |
|   |                          | 2. Reduce carbon footprint                                  |  |
| 9                                       | Environmental Benefits   | 1. Contributes to Net Zero 2060                             | Supports broader ESG commitments and national climate policy targets.              |
|   |                          | 2. Improves ESG reporting                                   |  |

Source: 2025 Author's Research

The environmental layer of a Greenomina's Business Model Canvas it underscores strategic role in an advancing PT Pertamina (Persero)'s efforts in decarbonization, in particular of Scope 3 emission tracking. The platform's functional value enabling users to monitor, calculate, and reduce indirect emissions which associated with business operations for example logistics, travel, and supply chain activities. Through the use of a lot of data, cloud computing, and digital interfaces, Greenomina minimizes reliance with some material resources while maximizing its scalability and an automation. In production process, the platform is co-developed with an academic and regulatory stakeholders to ensure a scientific validity and the policy alignment. In the use phase, it also promotes sustainable behavior by allowing employees to track their own carbon output and a conversion of reductions into measurable outcomes,

such as some offset credits via an IDX Carbon market. The end-of-life strategy focuses on the continuous improvement by embedding decarbonization culture and in adapting to regulatory changes. These features collectively will deliver environmental benefits, including an enhanced ESG reporting, transparency, and any contribution a Indonesia's Net Zero 2060 roadmap. This approach will aligning with any view that sustainable business models must account to any lifecycle environmental impacts, as noted by Joyce and Paquin (2016), who are always emphasizes to the need for an integration in ecological thinking to the core operational's logic through a models like a Triple Layer Business Model Canvas (TLBMC) (Pigneur et al., 2015).

**Table 4. Social Layer Business Model Canvas**

| Social Layer Business Model Canvas |                          |   |  |
|------------------------------------|--------------------------|---|--|
| No.                                | BMC Element              | Greenomina Case Description   | Analysis   |
| 1                                  | <b>Local Communities</b> | 1. Internal Pertamina employees   | Platform begins with internal focus but has scalable public potential.                   |
|                                    |                          | 2. Potential public expansion   |  |
| 2                                  | <b>Governance</b>        | 1. Support Net Zero 2060  | Ensures regulatory compliance and aligns with national/international emission standards. |
|                                    |                          | 2. Adheres to GHG Protocol and industry standards                           |  |
| 3                                  | <b>Employees</b>         | All Pertamina employees (including decision-makers)                         | Inclusive engagement promotes internal ownership of sustainability goals.                |
| 4                                  | <b>Social Value</b>      | 1. Increases individual awareness   | Empowers employees to become active participants in climate strategy.                    |
|                                    |                          | 2. Encourages accountability in emissions                                   |  |
| 5                                  | <b>Societal Culture</b>  | Builds a culture of emission awareness and eco-responsibility               | Fosters long-term behavioral and mindset change toward carbon responsibility.            |
| 6                                  | <b>Scale of Outreach</b> | Across multiple business units, expanding company-wide                      | Designed for wide-scale adoption and cultural integration within Pertamina.              |
| 7                                  | <b>End-User</b>          | Currently used by Pertamina employees; expansion to subsidiaries is ongoing | Initial internal success supports broader institutional roll-out.                        |
| 8                                  | <b>Social Impacts</b>    | Helps change employee habits and supports ESG transparency                  | Influences employee behavior while improving sustainability reporting.                   |
| 9                                  | <b>Social Benefits</b>   | 1. Strengthens Pertamina's sustainability leadership                        | Enhances corporate image while upskilling workforce in ESG.                              |
|                                    |                          | 2. Grows employees' sustainability knowledge                                |  |

Source: 2025 Author's Research

The social layer of the Greenomina Business Model Canvas revealing that the platform's potential to drives the cultural and behavioral transformation within PT Pertamina (Persero)'s organization by embedding a sustainability into employee practices. The platform initially is targeted towards internal Pertamina employees, improving a sense of community responsibility and offering any foundation for future expansions across the BUMN ecosystem or even to the public. Greenomina also supports social governance in adhering to a GHG Protocol standards and aligning to Indonesia's Net Zero Emissions 2060 strategy. It also empowers the employees by raising individual's awareness of carbon footprints and promoting its accountability in emission-related decisions. These values are reinforcing through internal campaigns, as feedback mechanisms, and a company-wide adoption across departments. The platform will also contributes to societal cultures of eco-

responsibility and a green innovation, facilitates a shift in organizational norms. Through the scale of outreach and potential to change the habits, Greenomina strengthens Pertamina's leadership in a national sustainability about the movement and supports ESG transparency. This will reflect the role of the social dimension in a sustainable business model innovation, where the employee empowerment and some cultural alignment are crucial for success implementation (Pigneur et al., 2015). The social layer, thus ensures that Greenomina is not just any technological solution, but also catalyst for an organizational transformation.

From TLBMC analysis, it reveals that economic layer showed the most immediate benefits, particularly in terms of the operational efficiency and a carbon cost-saving potentials. The outcomes also aligns with the organization's priority for alignment to sustainability with a financial performance. Meanwhile, the social layer is scored moderately, largely due to uneven levels of employee engagement across department despite the attractiveness of features that being embedded into Greenomina. According to the environmental layer, it conceptually strong, demonstrated the limitations in terms of measurable long-term impacts, likely due to platform's early stage and lack of formal integrations with IDX Carbon. These disparities reflect the organizational maturity in adopting a sustainability-oriented digital tools across all functions.

### Digital Transformation Canvas (DTC)

The Digital Transformation Canvas (DTC) framework used as the strategic tools in mapping many possible issue areas in order to identifying critical hurdles in implementing digital transformation efforts like Greenomina. Based on the stakeholder interviews and thematic coding analysis generates insights that revealed a lot of important problems in several different areas of the transformation process. To make sure that the fundamental obstacles were understood well, these difficulties were compiled and reevaluated.

**Table 5. Digital Transformation Canvas for Greenomina**

|                        |             | Strategic Decision Making for Greenomina Decarbonization Efforts |  |   |   |  |                        |
|------------------------|-------------|--|--|---|---|--|------------------------|
| DT Strategy            | Purpose     | 1. Green Energy Transition                                       | 2. Carbon Neutral Awareness                            | 3. Technology for Decarbonization               | 4. Revenue Stream (Long-term)           | 5. Carbon Emission Tracking              | 6. Carbon Trading      |
| DT Operational Pillars | People      | 1. All Employees   | 2. Task Force Team                                     | 3. Decision Maker                               |   |  |                        |
|                        | Process     | 1. Data Collection and Management                                | 2. Predictive and Analytical Processes                 | 3. Emission and Carbon Monitoring               | 4. Integration and User Engagement      | 5. Regulatory Compliance                 |                        |
|                        | Platform    | 1. Data Automation and Operational Platforms                     | 2. AI Driven Analytics                                 | 3. Strategic Integration and Project Engagement | 4. Analytics and Pattern Detection      |  |                        |
|                        | Partner     | 1. Industry and Corporate Collaborations                         | 2. Collaborative Innovation and Technology Partnership | 3. Government and Public Sector Entities        | 4. Specialized Sectors and Services     | 5. Academic and Educational Institutions |                        |
| DT Value               | Product     | 1. Greenomina Digital Platform                                   | 2. My Pertamina Application (for integration)          |   |   |  |                        |
|                        | Performance | 1. Market Engagement   | 2. Reputation and Public Trust                         | 3. Efficiency and Transition                    | 4. Compliance and Social Responsibility | 5. Emission Management                   | 6. Sustainable Finance |
|                        | Planet      | 1. Decarbonization Awareness                                     | 2. Sustainable Practices for Emission Reduction        | 3. Net Zero Emission 2060                       |   |  |                        |
| DT Pitfalls            | Privacy     | 1. Data Security Measurement                                     | 2. Regulatory Compliance                               | 3. Personal Data Protection                     |   |  |                        |
|                        | Protection  | 1. Data Integrity and Accuracy                                   | 2. Regulatory and Policy Alignment                     | 3. Accountability and Adaptability              | 4. Security Protocol                    |  |                        |
| Project Constraints    | Time        | Long-term  |  |   |   |  |                        |
|                        | Budget      | Confidential   |  |   |   |  |                        |
|                        | Risk        | Medium - Resistance to Change (Behavioral)                       |  |   |   |  |                        |

Source: Author's Research

The Digital Transformation Canvas (DTC) for Greenomina illustrated that a comprehensive, layered approaches to embedding the digital innovation into carbon management and sustainability strategy in PT Pertamina (Persero). The DT strategy reveals clear progressions from green energy transition and carbon neutrality awareness to the long-term revenue generation through a carbon trading. This is operationalized through four key pillars, which are: People, Process, Platform, and Partner. The platform involves not only to an internal task force teams and decision-makers but also an AI-driven analytics, strategic integration, and any partnerships with both public and private entities. The process pillar, especially to demonstrates that maturity by combining a data automation with some predictive analytics and the regulatory compliances mechanisms. Regarding the alignments with the best practices for the carbon monitoring and also ESG data standardization, that are very essentials to achieves the strategic goals for example an emission tracking and the Scope 3 reductions. This structured coordinations consistent with the frameworks like Elia et al.'s (2024) Digital Transformation Canvas, that emphasizes in aligning people, platforms, and processes to maximizing any sustainability outcomes through the digitization (Elia et al., 2024).

The DT value components, that are: Product, Performance, and Planet. It highlights the platform's ability to balance the technological utility with a sustainability impact. Greenomina, integrated with an applications like MyPertamina, it supports market engagement, a public trust, and also ESG transparency, all while promoting a sustainable behaviors at the individual employee level. Its value proposition extends beyond an environmental outcomes to the compliance, social responsibility, and also operational efficiency, meeting both the internal KPIs and broaders policy mandates such as the Net Zero Emission 2060. However, the DT pitfalls noted in the canvasthat data privacy, integrity, and also the regulatory protection, it indicates some areas that requiring robust governance. Personal data protection, a policy adaptability, and the cybersecurity are critical to maintaining platform in terms of trust and usability at scale. Additionally, project constraints such as behavioral resistances (a frequent challenge in the digital transformation) must addressed through the structured cultural changes and also capacity building. The perspectives is supported by (Gimpel et al., 2018), who emphasizes that the digital transformations must integrates a social, technological, and also governance dimensions to successfully embed sustainability across organizational practices.

### **Digital Transformation Canvas (DTC) – Leadership Analysis**

Five (5) strategic roles have been identified to support Greenomina's long-term development based on the findings of stakeholder interviews and thematic coding analysis. This comes after an examination of the Digital Transformation Canvas, which is explained as the following details:

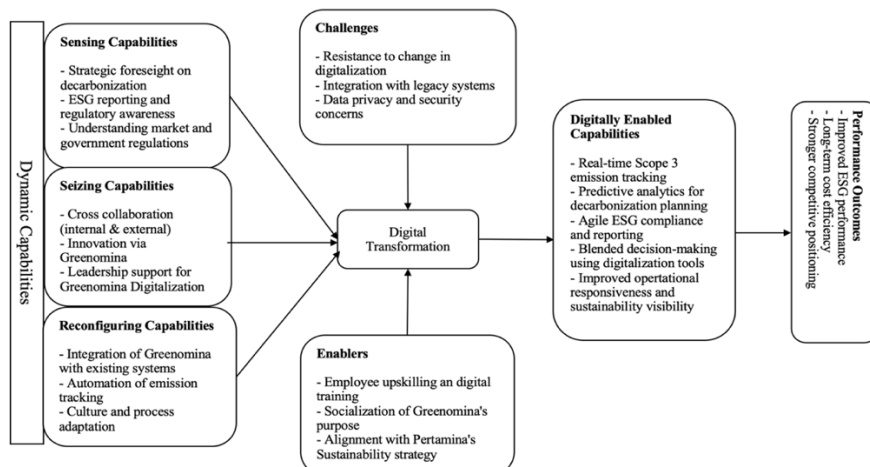
**Table 6. Digital Transformation Canvas (DTC) – Leadership Analysis**

| Roles                                   | Competencies  | Behaviors   | Enablers   |
|---|---|---|--|
| <b>Greenomina Task Force Leader</b>     | Understands carbon pricing, ESG, and stakeholder engagement | Leads with clear direction to unite departments                 | Backed by top management and aligned with Net Zero 2060 goals    |
| <b>Sustainability Team Collaborator</b> | Skilled in digital tools like emission tracking and AI      | Works across teams to ensure sustainability integration         | Supported by digital platforms and internal coordination efforts |
| <b>Digital Innovation Champion</b>      | Strong in data systems and innovation                       | Encourages teams to experiment with new technology              | Provided with training and test environments                     |
| <b>Senior Executive Advocate</b>        | Strategic thinking and policy expertise                     | Enables teams to make informed, bold decisions                  | Supported by resources and incentives for sustainability targets |
| <b>Decision Maker</b>                   | Balances innovation with business and regulation            | Sets priorities, manages budgets, and handles complex decisions | Guided by governance systems and risk frameworks                 |

Source: Author's processed original data

An Effective digital transformations of leadership in the Greenomina initiative at PT Pertamina (Persero) is characterized by the integration of strategic vision, cross-functional collaborations, and a deep understanding of carbon policy and the digital tools. The leadership structures spans from task force leaders who steer decarbonization goals to executives who is aligning the platform with a long-term business models and the risk frameworks. These leaders demonstrating any competencies in the ESG frameworks, data analytics, and regulatory navigations to empowering their teams to innovation, adapt, and contributes meaningfully to the sustainability KPIs. Behaviors such as assertiveness, collaboration, and a strong sense of purpose are supported by enablers like a top management endorsement, structured governance, and the internal training ecosystems. It will reflects the findings of (Kane et al., 2019), who emphasizes that the successful digital transformations requires leadership that improves a shared vision, enables agile experimentations, and also bridges technical and strategic domains to drive a sustainable innovation.

### Dynamic Capabilities of Greenomina Development

**Figure 3. Dynamic Capabilities of Greenomina Development**

Source: Author's Research inspired by Saedikya et. al., 2024 Framework

This diagram that inspired by (Saeedikiya et al., 2024) describes the comprehensive framework to explain how dynamic capabilities support the strategic decision-making in Greenomina's digitalization, especially in improving the energy efficiency and flexibility at PT Pertamina (Persero). The model is very structural around three core dynamic capabilities, which are: Sensing, Seizing, and Reconfiguring, all of which drive a digital transformation. A Sensing Capabilities focus on looking ahead in the decarbonization, understanding ESG frameworks, and also navigating the regulatory environment that really critical to anticipating an external changes and aligning Greenomina with national and with global sustainability targets. For top executives to be recognize strategic digital opportunities in the contexts of the energy transitions, this sensing function is very important.

Seizing Capabilities it places really strong emphasis on leadership a commitment to digitalization, innovation through the Greenomina internally, and external collaborations. PT Pertamina (Persero) can take any actions based on the strategic insights to obtained from the sensing phase to these operational levers. A cultural of shared ownership in decarbonization endeavor will strengthened by cross-functional collaboration and executive support, which is coordinating departmental goals with the digital objectives. Concurrently, through some of the process adaptation, emissions trackings automation, and Greenomina integration with legacy systems, Reconfiguring Capabilities facilitated in technical and organizational transformations. Through reorganized to digital environment, these capabilities are made sure that strategic decisions were not only made but also successfully carried out.

Some of Real-time Scope 3 emissions tracking, the predictive analytics, and precisely ESG reporting are just few examples of the digitally-powered of decision-making tools that make it more possible by the digital transformations made possible by these capabilities. The Decisions were made more quickly and also intelligently as a result. Decision-makers were able to strike balance between an environmental compliance and business efficiency grateful to the digital backbone's improvements as an operational agility and sustainability visibility. Despite the challenges for example: transitioning to change and data security issues, any factors like employee upskilling, Greenomina's purpose-driven communication, and alignment with PT Pertamina (Persero)'s sustainability strategy may helped overcome obstacles. Ultimately, the approach will results in measurable performances outcomes, especially: improved ESG results, the long-term cost efficiencies, and a stronger competitive position, effectively in addressing a strategic decisions with digital transformation to enhance an energy efficiency and also the flexibility.

According to illustration in Figure 3, Greenomina's digital transformations capabilities are centered around the sensing, seizing, and reconfiguring capabilities, which is align closely with its predictive analytics and also platform-based engagement features. The sensing capability reflected in Pertamina's abilities to identify emission sources across the business units, and the seizing capability enables inclusive participation and cross-departmental collaborations. However, the reconfiguring capability, it is involves long-term adaptive strategies shows limited

institutionalization, which is indicating room for improvement to digital agility and the cultural transformation. The figure helps to visualize how these capabilities interacts each others with identified challenges (for example: legacy systems, change fatigue), it supports the need for continuous upskilling and a strategic alignment.

## 5. Discussion

The findings of this study demonstrates that an implementation of digital platforms such as Greenomina is significantly enhances an organization's ability to manages Scope 3 carbon emissions through an internal behavioral change, the data transparency, and digital governance alignments. Greenomina transforms traditional carbon management by enabling real-time tracking, an employee-level accountability, and integrations with ESG frameworks, particularly in the complex energy sector like PT Pertamina (Persero). This digital approach complements to Indonesia's national carbon market's development (IDX Carbon) and it aligns with the broader Net Zero Emissions 2060 roadmap. The results are very consistent with the recent studies that emphasize the role of the digitalization in making intangible sustainability goals measurable, reportable, and verifiable through an integrated platforms and also stakeholder participations (Saedikya et al., 2024; Biswas et al., 2025).

The use of Triple Layered Business Model Canvas (TLBMC) reveals that Greenomina supports not only to environmental outcomes but also to creates long-term economic and social values. From an economic perspectives, Greenomina helps reduce an operational inefficiencies, introduces potential for a carbon monetization, and supports ESG ratings all while preparing Pertamina for future compliance costs associated with the emission trading systems. Environmentally, it provides tools to calculate, reduce, and offset the Scope 3 emissions using digital infrastructures that minimizes physical resource waste. Socially, the platform may enhances internal sustainability culture by engaging employees in a measurable low-carbon actions. These multi-layered impacts reinforces the principle that a sustainable innovation must be embedded holistically in organization's value creation logic, as already emphasized by Joyce and Paquin (2016).

However, regarding the transition to digital carbon accountability encounters several organizational and also technical barriers. The Digital Transformation Canvas (DTC) framework analysis is highlighted the challenges such as resistance to change, legacy system integrations issues, and the digital literacy gaps. These findings support the need for the dynamic capabilities especially: sensing, seizing, and reconfiguring capabilities as it outlined by Teece (2018). Greenomina's success thus depend on Pertamina's ability to continuously adapts, train employees, and align digital transformations initiatives with evolving regulations and the stakeholder expectations. In this contexts, digitally enabled capabilities such as the predictive analytics, user-centric platforms, and a real-time feedback loops become critical in supporting an operational agility and a strategic decision-making under any uncertainties.



Finally, the study provides any implications for both policy and practices. At the corporate level, firms in a carbon-intensive sectors can adopt platforms like Greenomina to not only to comply with carbon disclosure mandates but also to lead ESG innovation internally. At national level, the Indonesian government can also encourage SOEs and other large emitters to adopt any similar tools as a part of voluntary or mandatory carbon market readiness programs (Xie et al., 2024). Moreover, the combinations of employee engagements and digital governance showcased by PT Pertamina (Persero) can serve as model for how human capital and technology can jointly drives a climate action. As Indonesia continues to institutionalizes its carbon pricing framework, digital transformations will play an essential role in closing the accountability gap especially for the Scope 3 emissions which are often overlooked in conventional emission in a reporting systems (Guo & Tang 2024).

While a resistance to change and some digital literacy gaps is emerged as a significant challenges, the targeted mitigation strategies can enhances the adoption. For example, the structured onboarding programs, digital upskilling workshops, and gamified training modules that can foster platform engagements among non-technical employees. To address resistance, an internal agents of change and also the cross-functional sustainability champions can helps to translate organizational goals into the daily action, bridges the behavioral gap with peer-based influences. Additionally, integrating a Greenomina into an existing performances evaluation systems could reinforce the relevances and encourages the widespread use.

From a policy standpoints, additional cross collaborations with external stakeholders from the government through Financial Services Authority/*Otoritas Jasa Keuangan (OJK)* and Ministry of Environment/*Kementerian Lingkungan Hidup (KLHK)* could establish incentive schemes or pilot fundings for digital carbon management systems within SOEs. This could accelerate carbon market's readiness and to ensure alignment with IDX Carbon reporting standards. For practitioners, it is recommended that organizations form the dedicated carbon task forces, that integrates carbon tracking into ERP systems, and use digital dashboards to supports the executive's decision-making. These actions would help to institutionalize digital tools like Greenomina and also scale the impact beyond the pilot programs.

## 6. Conclusions

This study aims to explore how digital transformation can be leveraged to enhance carbon emissions management, with a particular focus on Scope 3 accountability in the energy sector. By analyzing the implementation of the Greenomina platform at PT Pertamina (Persero), the research demonstrates the transformative role of digital tools in supporting sustainability strategies, improving ESG performance, and driving organizational change. Through stakeholder interviews and the application of business model innovation frameworks, key insights were identified regarding both the enablers and barriers of this digital transition.

First, digital transformation was found to significantly support Scope 3 carbon accountability. Greenomina successfully introduced digital mechanisms for tracking and managing Scope 3 emissions—long considered the most complex and indirect category—making them more measurable and attributable, particularly for internal users. Second, aligning sustainability and digital strategies has proven to enhance ESG performance. By integrating Greenomina within ESG frameworks, Pertamina demonstrated that sustainability goals can be embedded into daily operations through data-driven platforms, thereby increasing transparency and regulatory compliance. Third, the application of the Triple Layered Business Model Canvas (TLBMC) illustrates Greenomina's multidimensional value: economically (through efficiency gains and potential carbon trading), environmentally (via Scope 3 tracking and emission reductions), and socially (by fostering employee engagement and sustainability awareness).

Moreover, digital capabilities such as sensing, seizing, and reconfiguring were identified as critical enablers of successful decarbonization efforts. Organizational learning and adaptive strategies play a vital role in supporting Pertamina's digital sustainability journey. Employee engagement emerged as central to the platform's success, as the system empowers staff to understand, measure, and reduce their carbon footprint, transforming them into active participants in the company's decarbonization roadmap. Despite these advancements, implementation barriers remain and require structured governance. Challenges include integration with legacy systems, digital literacy gaps, resistance to change, and the need for a formal data governance framework to manage the platform's growth.

The study also highlights that digital transformation enhances organizational agility and competitiveness. The use of predictive analytics, automated systems, and integrated platforms supports faster decision-making, regulatory readiness, and long-term competitive advantage. Furthermore, Greenomina presents a scalable model for other state-owned enterprises (SOEs) and carbon-intensive industries in Indonesia, with potential to serve as a standardized tool for emissions accountability and ESG reporting.

In conclusion, Greenomina plays a strategic role in enhancing Scope 3 carbon accountability through digital transformation, particularly within the context of a state-owned enterprise. Future research could explore the platform's scalability across other SOEs and its integration with carbon trading mechanisms such as IDX Carbon. For successful implementation, critical steps include embedding Greenomina into formal ESG frameworks, strengthening employee training, and aligning the system with national carbon policies to ensure long-term impact and adoption.

The study offers several recommendations: (1) institutionalize Greenomina within corporate policy and ESG reporting frameworks; (2) expand adoption across the SOE ecosystem to standardize digital carbon management and support national carbon trading readiness; (3) invest in digital upskilling and sustainability training for employees; (4) integrate Greenomina with enterprise systems and external carbon markets; (5) develop robust data governance and cybersecurity frameworks; (6)

leverage behavioral incentives to boost internal engagement; (7) collaborate with external stakeholders for continuous innovation; and (8) support government policymaking by sharing anonymized insights from the platform.

By implementing these recommendations, PT Pertamina (Persero) and similar companies in the energy sector can strengthen their commitment to decarbonization while building internal capabilities for long-term sustainability. The success of Greenomina can serve as a replicable model for digital carbon management across Indonesia's state-owned enterprises, supporting national carbon pricing mechanisms and ESG compliance. Ultimately, a digitally enabled, employee-driven, and data-informed approach will not only accelerate emissions reduction but also position organizations to lead in the global energy transition.

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