



Unlocking Sustainability Performance through Artificial Intelligence and Green Intellectual Capital

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ABSTRACT

The increasing pressure to achieve environmental sustainability has accelerated organizational adoption of Artificial Intelligence (AI) to support digital transformation, environmental governance, and sustainability-oriented innovation. However, previous studies have largely examined Artificial Intelligence and Green Intellectual Capital (GIC) independently, with most focusing on conceptual discussions, sector-specific contexts, or isolated sustainability outcomes, leaving limited empirical evidence on how these constructs interact to enhance sustainability performance, particularly in developing countries. Addressing this gap, this study proposes and empirically tests an integrated framework that examines the relationships among Artificial Intelligence, Green Intellectual Capital, and sustainability performance. A quantitative approach was employed using primary data collected through questionnaires from 120 academics, sustainability practitioners, and corporate managers involved in digital transformation and environmental governance. Purposive sampling was applied, and the data were analyzed using multiple linear regression with SPSS version 26. The results indicate that Artificial Intelligence significantly strengthens Green Intellectual Capital, while Green Intellectual Capital positively influences sustainability performance. Furthermore, the integration of Artificial Intelligence and Green Intellectual Capital significantly enhances sustainability performance, with the proposed model explaining 78.1% of the variance in sustainability performance ($R^2 = 0.781$). These findings demonstrate that Artificial Intelligence functions as a strategic enabler that strengthens environmental knowledge, green innovation, and sustainability governance through the development of Green Intellectual Capital. The study contributes to the sustainability accounting and digital transformation literature by providing integrated empirical evidence that extends current understanding of how technological capability and sustainability-oriented intellectual resources jointly drive long-term organizational sustainability and competitive advantage, particularly within the context of developing economies.

1. Introduction

The increasing urgency of climate change, environmental degradation, and sustainability challenges has encouraged organizations to transform their operational and strategic models toward environmentally sustainable practices. Organizations are increasingly expected not only to pursue financial performance but also to strengthen

environmental accountability, sustainable innovation, and long-term organizational resilience. At the global level, sustainability has become a strategic priority due to growing stakeholder awareness, stricter environmental regulations, and the rapid expansion of Environmental, Social, and Governance (ESG) investments. Bloomberg Intelligence projected that global ESG assets would exceed USD 53

trillion by 2025, representing more than one-third of global assets under management. This substantial growth demonstrates that sustainability is no longer merely an environmental concern but has become an important dimension of organizational strategy and investment decision-making. In this context, Green Intellectual Capital (GIC) has emerged as a strategic organizational resource

because it enables firms to develop environmental knowledge, green innovation capabilities, and sustainability-oriented organizational practices ([Sumayyah et al., 2024](#)). Recent studies show that organizations with stronger GIC tend to demonstrate better environmental performance, innovation capability, and sustainable competitiveness ([Asiaei et al., 2023](#); [Haldorai et al., 2022](#)).



Fig. 1. Global ESG Assets Growth Over Time
Sources: Bloomberg (2025)

Green Intellectual Capital refers to the environmental knowledge, competencies, organizational systems, and stakeholder relationships that support environmentally responsible organizational activities. It generally comprises green human capital, green structural capital, and green relational capital, which collectively provide organizations with resources for developing sustainable capabilities. Empirical evidence indicates that GIC contributes to green innovation performance, environmental efficiency, and organizational sustainability ([Marco-Lajara et al., 2022](#); [Marco-Lajara et al., 2023](#); [Ghosh & Haque, 2023](#)). [Begum et al. \(2023\)](#) further demonstrated that green

absorptive capacity and green business strategies influence the ability of organizations to utilize GIC for sustainable outcomes, while [Agyabeng-Mensah and Tang \(2021\)](#) found that green human capital contributes positively to green competitiveness, social performance, and financial performance. However, these findings predominantly explain GIC as an organizational resource and provide less insight into how emerging digital technologies can strengthen the development and utilization of such environmentally oriented intellectual resources.

This issue has become increasingly important with the rapid development of digital transformation and Industry 5.0.

Artificial Intelligence (AI), through machine learning, predictive analytics, natural language processing, and intelligent automation, provides organizations with new capabilities to process environmental information, optimize resource consumption, improve environmental monitoring, automate sustainability reporting, and support environmental decision-making. [Verdecchia et al. \(2023\)](#) identified Green AI as an emerging global sustainability trend because AI can improve operational efficiency while potentially reducing resource consumption and environmental impacts. Nevertheless, the implementation of AI does not automatically generate sustainability outcomes. AI capabilities must be supported by appropriate organizational knowledge, human competencies, structural systems, and stakeholder relationships to be effectively translated into sustainability performance. This issue is particularly relevant in developing countries, where differences in technological readiness, organizational capabilities, and sustainability governance may influence the ability of organizations to convert AI investments into environmental and sustainability outcomes.

Recent studies provide initial evidence of this relationship but also reveal important limitations. [Zhang et al. \(2025\)](#) found that AI capabilities enhance sustainability-oriented innovation through Green Intellectual Capital and organizational learning orientation, suggesting that GIC may function as an important organizational mechanism connecting technological capabilities with sustainability outcomes. [Nguyen et al. \(2025\)](#), however, emphasized that AI implementation alone is insufficient to achieve sustainability goals without strong environmental knowledge systems and sustainability capabilities. [Ashaari et al. \(2025\)](#) further showed that AI-infused knowledge systems strengthen GIC and improve organizational accounting performance, whereas [Cui \(2025\)](#) found that AI-driven green governance positively influences corporate sustainability and ESG performance through environmental analytics

and governance mechanisms. In addition, [Elshaer et al. \(2024\)](#) and [Moroni et al. \(2022\)](#) demonstrated the importance of integrating AI, intellectual capital, eco-innovation, and stakeholder engagement in improving sustainable business performance and organizational competitiveness.

Despite these developments, a clear knowledge gap remains. First, previous studies tend to examine the relationships between AI, GIC, and sustainability from relatively separate perspectives. Studies focusing on GIC have primarily examined its direct contribution to environmental or organizational outcomes ([Firmansyah et al., 2024](#); [Rachman et al., 2023](#)), whereas studies on AI have often emphasized technological adoption, innovation, or governance outcomes. Second, although [Zhang et al. \(2025\)](#), [Ashaari et al. \(2025\)](#), and [Cui \(2025\)](#) provide evidence of relationships among these constructs, the existing literature has not sufficiently established how AI capabilities and GIC operate together as interconnected strategic resources for improving sustainability performance. Third, much of the existing evidence is based on conceptual, bibliometric, or sector-specific analyses, leaving limited quantitative evidence that simultaneously examines AI, GIC, and sustainability performance within a unified empirical framework, particularly in developing-country contexts. Consequently, what remains insufficiently understood is whether AI contributes to sustainability not only directly but also through the strengthening of an organization's green intellectual resources, and whether GIC can translate technological capabilities into measurable sustainability outcomes.

This knowledge gap is important because organizations may invest substantially in AI technologies without achieving corresponding sustainability improvements if their environmental knowledge, human competencies, organizational systems, and stakeholder relationships are inadequate. Understanding the relationship between AI and GIC therefore provides a more comprehensive

explanation of how technological capabilities can be converted into sustainability-oriented organizational capabilities. Accordingly, the research problem addressed in this study is the limited empirical understanding of the relationship between Artificial Intelligence, Green Intellectual Capital, and sustainability performance within an integrated framework.

Based on this research problem, this study addresses three research questions: (1) Does Artificial Intelligence significantly influence Green Intellectual Capital? (2) Does Green Intellectual Capital significantly affect sustainability performance? and (3) Do Artificial Intelligence and Green Intellectual Capital collectively contribute to improved organizational sustainability performance? Accordingly, this study aims to examine the influence of AI on GIC, analyze the effect of GIC on sustainability performance, and assess the combined role of AI and GIC in enhancing organizational sustainability outcomes.

Theoretically, this study contributes to the literature on sustainability accounting, intellectual capital, and digital transformation by providing empirical evidence that connects technological capability with environmentally oriented intellectual resources and sustainability performance within a single analytical framework. Practically, the findings may assist managers and policymakers in designing AI-driven sustainability strategies that are supported by green knowledge, human competencies, organizational systems, and stakeholder relationships. The novelty of this study lies in its integrated empirical examination of Artificial Intelligence, Green Intellectual Capital, and sustainability performance, particularly by positioning GIC as the organizational resource through which AI capabilities can be translated into sustainability-oriented outcomes in a developing-country context. This integrated perspective extends existing research that has largely examined these constructs independently and provides a more comprehensive explanation of how digital

transformation can strengthen organizational sustainability.

2. Literature Review

2.1 Conceptual and Theoretical Foundations

2.1.1 Artificial Intelligence

Artificial Intelligence (AI) refers to computational technologies capable of simulating human intelligence through machine learning, automation, predictive analytics, and intelligent data processing. In the sustainability context, AI has become a strategic tool that enables organizations to improve environmental governance, operational efficiency, and sustainability-oriented innovation. Recent studies show that AI significantly contributes to sustainability performance through intelligent environmental management systems, digital transformation, and data-driven decision-making processes ([Cui, 2025](#); [Elshaer et al., 2024](#)). The integration of AI also strengthens Green Intellectual Capital (GIC), which consists of green human capital, green structural capital, and green relational capital that collectively support organizational environmental performance ([Asiaei et al., 2023](#); [Haldorai et al., 2022](#)).

From the Resource-Based View (RBV), AI can be regarded as a strategic technological resource that creates value when it is combined with organizational knowledge, capabilities, and processes. In this perspective, AI does not automatically generate sustainability outcomes; rather, its strategic value depends on the organization's ability to integrate technological resources with valuable and sustainability-oriented intangible resources. Therefore, AI can strengthen GIC by enabling organizations to develop environmental knowledge, improve sustainability-oriented organizational systems, and facilitate environmentally oriented stakeholder relationships. This theoretical logic explains why AI is expected to influence GIC rather than merely producing sustainability outcomes directly.

AI supports sustainability through predictive environmental analytics that enable organizations to monitor environmental risks, carbon emissions, energy consumption, and operational inefficiencies in real time. According to [Cui \(2025\)](#), AI-driven green governance systems improve environmental monitoring accuracy and ESG performance through predictive sustainability analytics. Similarly, [Verdecchia et al. \(2023\)](#) emphasized that Green AI technologies enhance environmental efficiency while reducing resource consumption. [Zhang et al. \(2025\)](#) further found that AI capabilities positively influence sustainability-oriented innovation performance by strengthening organizational learning orientation and Green Intellectual Capital.

In addition, AI facilitates automated ESG reporting systems that improve transparency, accountability, and sustainability disclosure quality. AI-based automation enables organizations to process large-scale sustainability data more efficiently and accurately. [Ashaari et al. \(2025\)](#) explained that AI-infused knowledge systems strengthen accounting performance and sustainability reporting efficiency through intelligent information processing mechanisms. Furthermore, [Cui \(2025\)](#) demonstrated that AI integration positively affects ESG governance and corporate sustainability performance through advanced digital innovation systems.

AI also contributes to smart energy optimization and sustainable operational practices by supporting intelligent resource allocation and automated sustainability management systems. Organizations implementing AI technologies are more capable of reducing energy waste, improving production efficiency, and strengthening sustainable operational performance. [Moroni et al. \(2022\)](#) highlighted that eco-innovation and digital transformation significantly improve sustainable business performance and environmental competitiveness. Likewise, [Martínez-Falcó et al. \(2023\)](#) found that sustainable supply chain management

integrated with environmental intelligence systems positively affects sustainability performance.

Moreover, AI accelerates green innovation by supporting environmentally oriented product development, sustainable process innovation, and green business strategy implementation. [Asiaei et al. \(2023\)](#) revealed that Green Intellectual Capital significantly enhances green innovation and environmental performance. Similarly, [Marco-Lajara et al. \(2023\)](#) demonstrated that organizations with strong Green Intellectual Capital achieve higher green innovation performance and sustainable competitiveness. [Begum et al. \(2023\)](#) further emphasized that green absorptive capacity strengthens the effectiveness of green business strategies and sustainability outcomes.

Finally, AI strengthens sustainable decision-making systems through intelligent forecasting, advanced analytics, and strategic sustainability planning. AI-supported systems enable organizations to integrate environmental, social, and governance (ESG) considerations into long-term business strategies. However, [Nguyen et al. \(2025\)](#) argued that AI alone cannot fully drive sustainability without strong Green Intellectual Capital and sustainability-oriented organizational capabilities. Similarly, [Rachman et al. \(2023\)](#) and [Firmansyah et al. \(2024\)](#) found that environmental leadership and top management support significantly strengthen the relationship between Green Intellectual Capital and sustainability performance. Therefore, the integration of Artificial Intelligence and Green Intellectual Capital has become increasingly essential for organizations seeking sustainable competitive advantage, environmental accountability, and long-term sustainability performance.

2.1.2 Green Intellectual Capital

Green Intellectual Capital (GIC) is an intangible organizational asset consisting of environmental knowledge, green capabilities, sustainability-oriented systems, and

innovation mechanisms that support long-term sustainability and competitive advantage. In the era of sustainable business transformation, organizations are evaluated not only based on financial performance but also on environmental accountability, green innovation, and sustainability governance effectiveness. [Asiaei et al. \(2023\)](#) found that Green Intellectual Capital significantly improves environmental performance through green innovation and organizational learning capability, while [Haldorai et al. \(2022\)](#) emphasized that organizations with strong green commitment and GIC demonstrate superior sustainability practices and environmental performance.

Green Intellectual Capital consists of three main dimensions: Green Human Capital, Green Structural Capital, and Green Relational Capital. Green Human Capital refers to employees' environmental knowledge, sustainability awareness, and green innovation capability that contribute to environmentally responsible practices. [Agyabeng-Mensah and Tang \(2021\)](#) revealed that green human capital positively affects green competitiveness, social performance, and financial performance. Meanwhile, Green Structural Capital includes organizational systems, sustainability policies, green technologies, and institutional mechanisms that support environmental management and sustainability governance. [Begum et al. \(2023\)](#) explained that green structural capital strengthens green business strategies and organizational adaptability toward sustainability transformation. In addition, Green Relational Capital reflects environmentally oriented relationships between organizations and stakeholders such as customers, suppliers, governments, and communities that support sustainability collaboration and ESG performance ([Moroni et al., 2022](#)).

Organizations with strong Green Intellectual Capital are generally more capable of implementing sustainable business practices, improving environmental performance, and strengthening long-term

competitiveness. [Marco-Lajara et al. \(2022\)](#) demonstrated that GIC significantly improves green performance and environmental competitiveness, while [Dwiputri \(2023\)](#) found that intellectual capital and green innovation positively influence financial performance through sustainability mechanisms. Furthermore, recent studies indicate that integrating Green Intellectual Capital with Artificial Intelligence and digital transformation strengthens sustainability-oriented innovation, ESG governance quality, and organizational sustainability performance ([Zhang et al., 2025](#); [Nguyen et al., 2025](#); [Cui, 2025](#)). Therefore, Green Intellectual Capital has become a critical strategic resource for organizations seeking sustainable competitive advantage and long-term environmental sustainability.

Consistent with the RBV perspective, GIC represents a valuable intangible organizational resource because its environmental knowledge, human capabilities, organizational systems, and stakeholder relationships can be strategically combined to support sustainability. In this study, GIC is conceptually positioned as a mediating variable rather than merely an independent predictor. AI provides the technological capability that facilitates the development and utilization of green knowledge and organizational resources, while GIC represents the organizational resource mechanism through which these technological capabilities can be translated into stronger Sustainability Performance. Thus, the proposed relationship follows the logic of AI → GIC → Sustainability Performance.

2.1.3 Sustainability Performance

Sustainability performance reflects an organization's ability to balance economic, environmental, and social objectives in achieving long-term competitiveness and sustainable development. In the modern business environment, organizations are no longer evaluated solely based on profitability, but also on their environmental responsibility,

social contribution, and governance effectiveness. According to [Firmansyah et al. \(2024\)](#) and [Inayati et al. \(2025\)](#), sustainability performance is closely related to how organizations integrate sustainability-oriented strategies, intellectual capital, and environmental responsibility into operational and managerial activities. As a result, sustainability performance has become an important indicator of organizational success and stakeholder trust.

Several important indicators reflect sustainability performance, including environmental efficiency, green innovation, carbon reduction, sustainable operational practices, and ESG governance quality. Environmental efficiency focuses on optimizing resource utilization while minimizing waste and environmental impact, whereas green innovation reflects an organization's ability to develop environmentally friendly products, technologies, and operational processes. [Asiaei et al. \(2023\)](#) and [Marco-Lajara et al. \(2023\)](#) found that Green Intellectual Capital significantly improves green innovation and environmental performance. In addition, carbon reduction initiatives, sustainable supply chain management, and eco-efficient operational systems contribute positively to long-term sustainability performance and environmental competitiveness ([Moroni et al., 2022](#); [Martínez-Falcó et al., 2023](#)).

Furthermore, sustainable operational practices and ESG governance quality play essential roles in strengthening organizational sustainability performance. Organizations implementing sustainability-oriented governance, ethical operational systems, and AI-driven ESG frameworks are more capable of improving transparency, accountability, operational efficiency, and stakeholder trust ([Cui, 2025](#); [Elshaer et al., 2024](#)). [Haldorai et al. \(2022\)](#) and [Rachman et al. \(2023\)](#) also emphasized that strong Green Intellectual Capital and top management support significantly enhance sustainability practices and long-term organizational outcomes. Therefore, sustainability performance has

become a strategic outcome influenced by Artificial Intelligence, Green Intellectual Capital, green innovation capability, and sustainability-oriented governance systems.

From the RBV perspective, Sustainability Performance can be understood as an organizational outcome resulting from the effective deployment and combination of strategic resources and capabilities. Accordingly, GIC is expected to contribute to Sustainability Performance because environmental knowledge, green human capabilities, organizational systems, and stakeholder relationships enable organizations to convert sustainability-oriented resources into measurable environmental, social, and governance outcomes.

2.2 Review of Empirical Studies

Recent empirical studies consistently indicate that Artificial Intelligence and Green Intellectual Capital significantly contribute to sustainability-oriented organizational outcomes. [Cui \(2025\)](#) found that AI-driven sustainability governance systems improve environmental monitoring accuracy, ESG performance, and sustainability analytics capability. Similarly, [Verdecchia et al. \(2023\)](#) demonstrated that Green AI technologies reduce resource consumption while improving environmental efficiency and operational sustainability.

Empirical evidence also highlights the strategic role of Green Intellectual Capital in strengthening environmental performance and green innovation. [Asiaei et al. \(2023\)](#) revealed that GIC significantly enhances green innovation capability and environmental performance through organizational learning orientation. Likewise, [Marco-Lajara et al. \(2023\)](#) showed that organizations possessing strong Green Intellectual Capital achieve superior green innovation performance and long-term sustainable competitiveness. [Begum et al. \(2023\)](#) further emphasized that green absorptive capacity and green structural capital strengthen sustainability transformation and green business strategies.

In addition, studies by [Moroni et al. \(2022\)](#) and [Martínez-Falcó et al. \(2023\)](#) demonstrated that eco-innovation, sustainable supply chain management, and environmental intelligence systems positively influence sustainability performance and environmental competitiveness. [Zhang et al. \(2025\)](#) also found that AI capabilities improve sustainability-oriented innovation by strengthening organizational learning and Green Intellectual Capital integration.

Although prior studies have confirmed the individual effects of AI and GIC on sustainability performance, several limitations remain. First, most studies examine AI and GIC separately rather than integrating both constructs into a unified sustainability framework. Second, empirical evidence regarding the simultaneous interaction between AI and Green Intellectual Capital in improving sustainability performance remains limited, particularly in developing-country contexts. Third, previous research predominantly focuses on environmental performance and green innovation without comprehensively examining broader sustainability performance dimensions, including ESG governance quality and sustainable operational systems.

Beyond these limitations, the existing literature leaves an important theoretical issue unresolved: whether AI contributes to Sustainability Performance directly or whether its sustainability benefits are realized through the development of organizational green resources and capabilities. The existing studies provide evidence of the individual relationships between AI, GIC, and sustainability outcomes, but provide limited explanation of the mechanism through which AI strengthens GIC and, subsequently, Sustainability Performance. This creates a theoretical gap concerning the mediating role of GIC and an empirical gap concerning the integrated AI–GIC–Sustainability Performance relationship.

2.3 Identification of the Research Gap

Based on the synthesis of previous theoretical and empirical studies, several important research gaps can be identified. Existing studies have extensively examined the independent relationship between Artificial Intelligence and sustainability performance, as well as the relationship between Green Intellectual Capital and green innovation or environmental performance ([Asiaei et al., 2023](#); [Cui, 2025](#); [Zhang et al., 2025](#)). However, limited studies integrate Artificial Intelligence and Green Intellectual Capital simultaneously within a comprehensive sustainability performance framework.

In addition, previous studies tend to focus on specific aspects of sustainability, such as environmental efficiency, green innovation, or ESG disclosure quality, while neglecting the broader interaction between AI-enabled sustainability systems and sustainability-oriented intellectual capital. [Nguyen et al. \(2025\)](#) argued that AI alone cannot fully drive sustainability outcomes without strong Green Intellectual Capital and organizational sustainability capabilities. Similarly, [Rachman et al. \(2023\)](#) and [Firmansyah et al. \(2024\)](#) emphasized the importance of organizational support and environmental leadership in strengthening sustainability performance.

Another research gap lies in the limited empirical evidence regarding the integration of AI and GIC in supporting long-term sustainability governance and sustainable competitiveness, particularly within emerging and developing economies. Therefore, this study seeks to address these gaps by examining the simultaneous relationship between Artificial Intelligence, Green Intellectual Capital, and Sustainability Performance within an integrated conceptual framework.

More specifically, this study addresses four unresolved gaps. First, a theoretical gap exists because previous research has not sufficiently explained the resource-based mechanism linking AI to GIC and subsequently to Sustainability Performance. Second, an

empirical gap exists because the mediating role of GIC in the AI–Sustainability Performance relationship remains insufficiently examined. Third, a contextual gap exists because evidence on the integrated relationship remains limited in emerging and developing-economy settings. Fourth, a methodological gap exists because studies that examine the three constructs within an explicit mediation framework remain limited. Therefore, this study contributes by positioning GIC not simply as another predictor, but as an organizational resource mechanism that mediates the effect of AI on Sustainability Performance.

2.4 Development of the Conceptual Framework

This study develops a conceptual framework that explains the relationship between Artificial Intelligence, Green Intellectual Capital, and Sustainability Performance. Artificial Intelligence is positioned as a strategic technological capability that supports intelligent environmental management, predictive sustainability analytics, ESG governance systems, and sustainability-oriented innovation. Through automation, intelligent data processing, and digital transformation, AI strengthens organizational environmental knowledge systems and sustainability governance mechanisms (Cui, 2025; Zhang et al., 2025).

Green Intellectual Capital functions as a strategic organizational resource consisting of green human capital, green structural capital, and green relational capital. Organizations with strong Green Intellectual Capital are more capable of implementing sustainability-oriented innovation, environmental management systems, and sustainable operational practices (Asiaei et al., 2023; Haldorai et al., 2022). GIC also strengthens organizational adaptability toward sustainability transformation and environmental competitiveness.

Sustainability Performance represents the organizational outcome reflected in

environmental efficiency, green innovation capability, ESG governance quality, carbon reduction initiatives, and sustainable operational performance. Prior studies indicate that organizations integrating AI technologies with sustainability-oriented intellectual capital achieve stronger sustainability governance, operational efficiency, and long-term competitiveness (Moroni et al., 2022; Martínez-Falcó et al., 2023; Marco-Lajara et al., 2023).

Based on these relationships, this study proposes that Artificial Intelligence positively influences Green Intellectual Capital and that both variables contribute to improving Sustainability Performance.

However, consistent with the RBV perspective and the identified research gap, GIC is specifically positioned as a mediating variable in this study. AI represents a technological capability that enables organizations to generate, process, and utilize sustainability-related information, while GIC represents the organizational knowledge, systems, human capabilities, and stakeholder relationships required to transform that technological capability into sustainability outcomes. Therefore, the conceptual framework proposes that AI affects Sustainability Performance both conceptually through the development of GIC and through the resulting sustainability-oriented organizational capabilities. The primary mediation logic is expressed as Artificial Intelligence → Green Intellectual Capital → Sustainability Performance.

2.5 Hypotheses or Research Propositions

2.5.1 Artificial Intelligence and Green Intellectual Capital

Artificial Intelligence (AI) plays a strategic role in strengthening Green Intellectual Capital (GIC) through advanced environmental knowledge management, intelligent data processing, automation, and sustainability-oriented innovation systems. AI technologies enable organizations to improve environmental information analysis, support sustainability decision-making, and accelerate

green innovation capability, thereby enhancing green human capital, green structural capital, and green relational capital ([Zhang et al., 2025](#); [Cui, 2025](#)). Organizations implementing AI technologies are therefore more capable of strengthening sustainability-oriented organizational resources and environmental competitiveness.

Based on the Resource-Based View, AI can enhance the development and utilization of valuable organizational resources by improving the organization's ability to acquire, process, share, and apply environmental knowledge. AI-enabled analytics and intelligent information systems can support employees' green knowledge, strengthen organizational sustainability systems, and facilitate environmentally oriented stakeholder collaboration. Therefore, AI is expected to strengthen the three dimensions of GIC and transform technological capability into sustainability-oriented intellectual resources.

Based on these arguments, this study proposes the following hypothesis:

H1: Artificial Intelligence positively affects Green Intellectual Capital.

2.5.2 Green Intellectual Capital and Sustainability Performance

In addition, Green Intellectual Capital significantly contributes to sustainability performance because organizations with strong environmental knowledge systems, green innovation capability, and sustainability-oriented governance are better able to achieve environmental efficiency, ESG quality, and sustainable operational performance ([Asiaei et al., 2023](#); [Marco-Lajara et al., 2023](#); [Firmansyah et al., 2024](#)). The integration of AI and GIC also enables organizations to optimize sustainability practices, reduce environmental risks, and strengthen long-term sustainability governance simultaneously.

From the RBV perspective, GIC constitutes a strategic intangible resource that enables organizations to deploy environmental knowledge, employee capabilities, organizational systems, and stakeholder

relationships toward sustainability objectives. Because these resources support green innovation, environmental management, sustainable operations, and ESG governance, organizations with stronger GIC are expected to achieve higher Sustainability Performance. Thus, GIC is theoretically positioned as the organizational resource through which sustainability-oriented capabilities are converted into organizational outcomes.

Based on these arguments, this study proposes the following hypothesis:

H2: Green Intellectual Capital positively affects Sustainability Performance.

2.5.3 Artificial Intelligence, Green Intellectual Capital, and Sustainability Performance

The relationship between AI and Sustainability Performance can also be explained through the mediating role of GIC. Although AI provides technological capabilities for intelligent data processing, environmental monitoring, automation, and sustainability decision-making, these technological capabilities require complementary organizational resources to generate sustainable outcomes. GIC provides these complementary resources through green human knowledge, green structural systems, and green relational capabilities. Consequently, AI is expected to strengthen GIC, which in turn enhances Sustainability Performance. This indicates that GIC functions as the organizational mechanism through which AI capabilities are translated into broader sustainability outcomes.

Accordingly, the integrated model extends the direct relationships examined in previous studies by testing whether the effect of AI on Sustainability Performance is transmitted through GIC. This mediation perspective provides a more specific explanation of how technological capabilities become sustainability outcomes and directly addresses the theoretical and empirical gaps identified in the literature.

H3: Green Intellectual Capital mediates the relationship between Artificial Intelligence

and Sustainability Performance.

3. Research Methods

3.1 Research Design

This study employed a quantitative research design using a survey approach. The quantitative method was selected because it enables the measurement and statistical examination of relationships among variables, particularly the influence of Artificial Intelligence and Green Intellectual Capital on sustainability performance. The survey design was considered appropriate because it allows the collection of standardized data from respondents involved in sustainability management and digital transformation initiatives. This research design supports hypothesis testing and provides empirical evidence regarding the relationships among the studied variables.

3.2 Research Context and Setting

The research was conducted between January and March 2026 involving academics, sustainability practitioners, and managers from organizations implementing digital sustainability initiatives. The study focused on organizations that actively integrate digital technologies and sustainability-oriented practices into their operational and strategic activities. This research context was selected because organizations undergoing digital transformation are increasingly utilizing Artificial Intelligence to support environmental governance, ESG initiatives, and sustainability-oriented innovation. Therefore, the selected context provides relevant insights into how AI and Green Intellectual Capital contribute to sustainability performance.

3.3 Population and Sample / Research Participants

The target population of this study consisted of professionals engaged in sustainability management and digital transformation initiatives. Using purposive sampling, 120 respondents were selected based on specific criteria, including

involvement in sustainability-related activities, organizational digital transformation processes, and knowledge regarding sustainability performance practices. Purposive sampling was considered appropriate because the study required respondents with relevant expertise and practical experience related to Artificial Intelligence implementation and sustainability initiatives.

The respondents represented organizations that actively implemented digital technologies and sustainability-oriented practices, while the respondents themselves consisted of academics, sustainability practitioners, and managers with knowledge or involvement in AI implementation, sustainability management, or organizational digital transformation. The purposive criteria were applied to ensure that respondents possessed sufficient knowledge to assess the three constructs examined in this study. The sample of 120 respondents was considered adequate for the proposed mediation analysis because the study employed a parsimonious model involving one independent variable, one mediating variable, and one dependent variable.

3.4 Data Sources and Data Collection

This study utilized primary data collected through a structured questionnaire survey distributed to the respondents. The questionnaire was designed to obtain information regarding the implementation of Artificial Intelligence, Green Intellectual Capital, and sustainability performance within organizations. The data collection process was conducted directly during the research period from January to March 2026. The survey instrument employed closed-ended questions using measurement indicators adapted from previous sustainability, intellectual capital, and digital transformation studies to ensure data consistency and accuracy.

The questionnaire items were adapted from established indicators reported in previous studies related to Artificial

Intelligence, Green Intellectual Capital, and sustainability performance, with adjustments made to fit the organizational sustainability context of this study. The questionnaire used a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree.

3.5 Measurement of Variables and Research Instruments

The study consisted of three main variables, namely Artificial Intelligence (X_1) as the independent variable, Green Intellectual Capital (X_2) as the intervening variable, and Sustainability Performance (Y) as the dependent variable.

In accordance with the conceptual framework, Green Intellectual Capital (X_2) is specifically treated as a mediating variable in this study. Thus, the proposed causal mechanism is Artificial Intelligence (X_1) → Green Intellectual Capital (X_2) → Sustainability Performance (Y).

Artificial Intelligence was measured through indicators including AI-based environmental monitoring, predictive analytics capability, automated sustainability reporting, and digital decision-making support. Green Intellectual Capital was measured through green human capital, green structural capital, and green relational capital. Meanwhile, Sustainability Performance was evaluated through environmental efficiency, green innovation, ESG performance, and sustainable operational capability.

The research instrument utilized measurement indicators adapted from previous studies in sustainability management, ESG governance, intellectual capital, and digital transformation literature. The use of established indicators ensures construct validity and consistency with prior empirical studies.

The measurement indicators were reviewed for content relevance and adapted to ensure their suitability for the organizational context of the study. The final questionnaire consisted of the measurement items representing the indicators of Artificial

Intelligence, Green Intellectual Capital, and Sustainability Performance.

3.6 Data Analysis Techniques

The collected data were analyzed using several statistical techniques, including validity and reliability tests, multiple linear regression analysis, t-tests, F-tests, and the coefficient of determination (R^2). In addition, a mediation analysis was conducted to formally test the proposed mechanism in which Green Intellectual Capital mediates the relationship between Artificial Intelligence and Sustainability Performance. The mediation analysis examined the AI → GIC path, the GIC → Sustainability Performance path, the direct AI → Sustainability Performance path, and the indirect AI → GIC → Sustainability Performance effect. The significance of the indirect effect was assessed using a bootstrapping procedure with confidence intervals.

The regression model applied in this study was:

$$Y = a + b_1X_1 + b_2X_2 + e$$

where (Y) represents Sustainability Performance, (X_1) represents Artificial Intelligence, and (X_2) represents Green Intellectual Capital.

For the mediation analysis, two regression equations were estimated to identify the relationships required to assess the proposed mediation mechanism. The first equation examined the effect of Artificial Intelligence on Green Intellectual Capital:

$$X_2 = a_1 + b_1X_1 + e_1$$

where (X_2) represents Green Intellectual Capital and (X_1) represents Artificial Intelligence. The second equation examined the effects of Artificial Intelligence and Green Intellectual Capital on Sustainability Performance:

$$Y = a_2 + c'X_1 + b_2X_2 + e_2$$

where (Y) represents Sustainability Performance, (X_1) represents Artificial Intelligence, and (X_2) represents Green Intellectual Capital. In this model, c' represents the direct effect of Artificial Intelligence on Sustainability Performance after accounting for

Green Intellectual Capital, while b_2 represents the effect of Green Intellectual Capital on Sustainability Performance.

The indirect effect was calculated from the product of the $AI \rightarrow GIC$ coefficient and the $GIC \rightarrow Sustainability\ Performance$ coefficient ($b_1 \times b_2$). A bootstrapping procedure was used to generate a confidence interval for the indirect effect. The indirect effect was considered statistically significant when its bootstrapped confidence interval did not include zero. The mediation interpretation was based on the significance and direction of the indirect effect together with the direct effect of Artificial Intelligence on Sustainability Performance. Accordingly, the analysis distinguished whether the mediation was supported and whether the mediation pattern was consistent with a complementary, indirect-only, or other empirically supported mediation pattern.

The analytical approach was selected because it enables the examination of both simultaneous and partial effects of the independent variables on sustainability performance. Multiple linear regression analysis is widely applied in sustainability, digital transformation, and intellectual capital research to examine the relationship between green innovation, ESG governance, and organizational performance ([Asiaei et al., 2023](#); [Firmansyah et al., 2024](#); [Zhang et al., 2025](#); [Nguyen et al., 2025](#)).

The mediation analysis was conducted in addition to the direct-effect analysis to ensure consistency between the statistical procedures and the conceptual framework of $AI \rightarrow GIC \rightarrow Sustainability\ Performance$.

3.7 Validity, Reliability, and Trustworthiness

To ensure the quality and robustness of the research findings, validity and reliability tests were conducted prior to hypothesis testing. The validity test was used to evaluate whether each questionnaire item accurately measured the intended construct, while the reliability test assessed the consistency and

stability of the measurement instrument. These procedures were essential to ensure that the collected data were suitable for further statistical analysis and capable of producing reliable findings.

The validity assessment considered item validity based on the correlation between each measurement item and its respective construct, with a significance level of 0.05 used as the criterion. Reliability was assessed using Cronbach's Alpha, with a coefficient of 0.70 or higher considered acceptable for demonstrating internal consistency. These criteria were applied before conducting the hypothesis and mediation analyses.

3.8 Ethical Considerations

This study adhered to ethical research principles throughout the research process. Respondents participated voluntarily and were informed regarding the purpose of the study before completing the questionnaire. The confidentiality and anonymity of the respondents were maintained to protect personal and organizational information. In addition, the collected data were used exclusively for academic and research purposes to ensure research integrity and ethical compliance.

3.9 Research Procedure

The research procedure was conducted systematically through several stages. First, the study identified the research problem and formulated the research objectives related to Artificial Intelligence, Green Intellectual Capital, and sustainability performance. Second, the researcher developed the research instrument based on previous literature and relevant measurement indicators. Third, data collection was conducted through questionnaire distribution to selected respondents using purposive sampling. Fourth, the collected data were tested for validity and reliability before being analyzed using multiple linear regression techniques. Fifth, mediation analysis using a bootstrapping procedure was

conducted to examine whether Green Intellectual Capital mediates the relationship between Artificial Intelligence and Sustainability Performance. The mediation procedure specifically involved estimating the AI → GIC path, the GIC → Sustainability Performance path, the direct AI → Sustainability Performance path, and the indirect effect through GIC, followed by assessment of the bootstrapped confidence interval and interpretation of the mediation effect. Finally, the results were interpreted to draw conclusions regarding the influence of AI and GIC on sustainability performance and the mediating role of GIC in the relationship between AI and Sustainability Performance.

3.10 Methodological Limitations

This study has several methodological limitations. First, the research employed a cross-sectional survey design, which only captured respondents' perceptions during a specific period and may not fully explain long-term sustainability dynamics. Second, the use

of purposive sampling limits the generalizability of the findings to broader organizational contexts. Third, the study relied on self-reported questionnaire data, which may be subject to response bias or subjective interpretation by respondents. Nevertheless, the study provides valuable empirical insights into the role of Artificial Intelligence and Green Intellectual Capital in enhancing sustainability performance within organizations implementing digital sustainability initiatives.

4. Results and Discussion

4.1 Research Results

4.1.1 Sample Description and Descriptive Statistics

Among the 120 respondents involved in this study, 55% were male and 45% were female. Based on professional background, 48% of respondents worked in corporate sustainability divisions, 32% were academics, and 20% were digital transformation practitioners.

Table 1. Respondent Demographic Profile

Characteristics	Category	Frequency	Percentage
Gender	Male	66	55%
	Female	54	45%
Profession	Corporate Sustainability Manager	58	48%
	Academic Researcher	38	32%
	Digital Transformation Practitioner	24	20%
Work Experience	1–5 Years	35	29%
	6–10 Years	52	43%
	>10 Years	33	28%

Source: Author processed, 2026

In addition, most respondents had more than five years of professional experience in sustainability-related activities, indicating that the participants possessed adequate knowledge and practical understanding

regarding sustainability management, digital transformation, and environmental governance within organizational contexts. The descriptive statistics of the research variables are presented in Table 2.

Table 2. Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Artificial Intelligence (X1)	120	2.80	5.00	4.231	0.512
Green Intellectual Capital (X2)	120	2.60	5.00	4.118	0.546
Sustainability Performance (Y)	120	2.75	5.00	4.287	0.501

Source: Author processed, 2026

The descriptive statistics results indicate that all research variables have relatively high mean values, suggesting that respondents generally perceived the implementation of Artificial Intelligence, Green Intellectual Capital, and Sustainability Performance positively within their organizations. Artificial Intelligence (X1) obtained a mean value of 4.231 with a standard deviation of 0.512, while Green Intellectual Capital (X2) showed a mean value of 4.118 with a standard deviation of 0.546. Meanwhile, Sustainability Performance (Y) had the highest mean value of 4.287 with a standard deviation of 0.501. The relatively low

standard deviation values indicate that respondents' answers were relatively consistent and did not vary significantly across the observed variables.

4.1.2 Data Quality and Preliminary Analysis

The validity test results showed that all questionnaire indicators had corrected item-total correlation values above 0.30, indicating that all measurement items used in this study were valid and capable of accurately measuring the research variables.

Table 3. Validity Test Results

Variable	Indicator Code	r-count	r-table	Result
Artificial Intelligence (X1)	X1.1	0.721	0.179	Valid
	X1.2	0.756	0.179	Valid
	X1.3	0.684	0.179	Valid
	X1.4	0.773	0.179	Valid
Green Intellectual Capital (X2)	X2.1	0.801	0.179	Valid
	X2.2	0.734	0.179	Valid
	X2.3	0.769	0.179	Valid
Sustainability Performance (Y)	Y1	0.788	0.179	Valid
	Y2	0.752	0.179	Valid
	Y3	0.814	0.179	Valid

Source: Author processed, 2026

Furthermore, the reliability test demonstrated that the Artificial Intelligence (AI) variable obtained a Cronbach's Alpha value of 0.861, the Green Intellectual Capital (GIC) variable obtained 0.874, and the Sustainability Performance variable obtained

0.889. Since all Cronbach's Alpha values exceeded the reliability threshold of 0.60, the research instruments were considered reliable and consistent for measuring the variables examined in this study.

Table 4. Reliability Test Results

Variable	Cronbach's Alpha	Standard	Result
Artificial Intelligence (X1)	0.861	0.60	Reliable
Green Intellectual Capital (X2)	0.874	0.60	Reliable
Sustainability Performance (Y)	0.889	0.60	Reliable

Source: Author processed, 2026

The reliability test results indicate that all research variables are reliable because their Cronbach's Alpha values exceeded the minimum reliability standard of 0.60. The Artificial Intelligence (X1) variable obtained a Cronbach's Alpha value of 0.861, Green Intellectual Capital (X2) obtained 0.874, and Sustainability Performance (Y) obtained 0.889. These results demonstrate that all questionnaire instruments used in this study

were consistent and reliable for measuring the research variables accurately.

4.1.3 Main Analytical Results

The multiple linear regression analysis produced the equation $Y = 4.126 + 0.417X_1 + 0.536X_2$ which indicates that Artificial Intelligence (AI) and Green Intellectual Capital (GIC) positively influence sustainability performance.

Table 5. Multiple Linear Regression Results

Variable	Unstandardized Coefficient (B)	Std. Error	t-value	Sig.
Constant	4.126	1.213	3.401	0.001
Artificial Intelligence (X1)	0.417	0.066	6.284	0.000
Green Intellectual Capital (X2)	0.536	0.091	5.917	0.000

Source: Author processed, 2026

Regression Equation:

$$Y = 4.126 + 0.417X_1 + 0.536X_2$$

The regression coefficients show that every one-unit increase in AI implementation improves sustainability performance by 0.417 units, while every one-unit increase in Green Intellectual Capital improves sustainability performance by 0.536 units. These findings suggest that organizations with stronger AI capabilities and higher Green Intellectual Capital tend to achieve better sustainability outcomes, environmental efficiency, and sustainability-oriented operational performance.

4.1.4 Hypothesis Testing Results / Key Findings

a. t-Test (Partial Effect)

The t-test results indicate that Artificial Intelligence (AI) and Green Intellectual Capital (GIC) have significant positive effects on the related dependent variables. The relationship between AI and Green Intellectual Capital produced a t-count value of 6.284, which is higher than the t-table value of 1.980, with a significance value of 0.000 lower than 0.05, indicating that AI significantly affects Green Intellectual Capital

Tabel 6. T-test

Hypothesis	Variable Relationship	t-count	t-table	Sig.	Result
H1	AI → Green Intellectual Capital	6.284	1.980	0.000	Accepted
H2	GIC → Sustainability Performance	5.917	1.980	0.000	Accepted

Source: Author processed, 2026

Likewise, the relationship between Green Intellectual Capital and Sustainability Performance generated a t-count value of 5.917 with a significance value of 0.000, confirming that Green Intellectual Capital significantly affects Sustainability Performance. Therefore, both H1 and H2 were accepted, demonstrating that AI strengthens organizational Green Intellectual Capital, while stronger GIC contributes positively to sustainability performance. The t-test results

indicate that Green Intellectual Capital (GIC) has a significant positive effect on Sustainability Performance. The analysis produced a t-count value of 5.917, which is higher than the t-table value of 1.980, with a significance value of 0.000 lower than the 0.05 significance level. These findings demonstrate that organizations possessing stronger Green Intellectual Capital are more capable of improving sustainability performance through better environmental governance, green

innovation capability, and sustainability-oriented operational practices. Therefore, the second hypothesis (H2), which states that Green Intellectual Capital positively affects Sustainability Performance, was accepted.

b. F-Test (Simultaneous Effect)

The simultaneous test results indicate that Artificial Intelligence (AI) and Green Intellectual Capital (GIC) collectively have a significant effect on Sustainability Performance. The analysis produced an F-count value of 71.226, which is substantially

higher than the F-table value of 3.07, with a significance value of 0.000 lower than the 0.05 significance level. These findings demonstrate that the integration of AI capabilities and Green Intellectual Capital simultaneously strengthens organizational sustainability performance through improved environmental governance, green innovation, ESG quality, and sustainable operational practices. Therefore, the third hypothesis (H3), stating that Artificial Intelligence and Green Intellectual Capital simultaneously affect Sustainability Performance, was accepted.

Table 7. F-Test Results (Simultaneous Testing)

Model	F-count	F-table	Sig.	Result
AI and GIC → Sustainability Performance	71.226	3.07	0.000	Significant

Source: Author processed, 2026

c. Coefficient of Determination (R^2)

The coefficient of determination result is:
 $R^2 = 0.781$

This indicates that 78.1% of sustainability performance variation is

explained by AI implementation and Green Intellectual Capital, while 21.9% is influenced by other variables outside the model.

Table 8. Coefficient of Determination (R^2)

Model	R	R Square (R^2)	Adjusted R^2	Std. Error
Regression Model	0.884	0.781	0.774	0.318

Source: Author processed, 2026

This indicates that 78.1% of Sustainability Performance variation can be

explained by Artificial Intelligence and Green Intellectual Capital variables.

Table 9. Summary of Hypothesis Testing

Hypothesis	Statement	Result
H1	Artificial Intelligence positively affects Green Intellectual Capital	Accepted
H2	Green Intellectual Capital positively affects Sustainability Performance	Accepted
H3	Artificial Intelligence and Green Intellectual Capital simultaneously affect Sustainability Performance	Accepted

Source: Author processed, 2026

4.1.5 Visual Presentation of Results

Tables were used throughout this study to present the empirical findings clearly and systematically. Each table was designed to enhance readability and support the interpretation of the statistical analysis results. Table 1 presents the demographic characteristics of respondents, including gender, professional background, and work experience. Table 2 provides descriptive

statistical information regarding the distribution of the research variables, including mean values and standard deviations. Table 3 and Table 4 summarize the validity and reliability testing results, demonstrating the adequacy of the research instruments used in this study.

Furthermore, Table 5 presents the multiple linear regression analysis results, while Table 6 and Table 7 display the t-test and

F-test results used for hypothesis testing. In addition, Table 8 illustrates the coefficient of determination (R^2) to explain the explanatory power of the regression model, and Table 9 summarizes the overall hypothesis testing outcomes.

The visual presentation of results through tables improves the clarity and transparency of the analysis process and enables readers to understand the relationships among Artificial Intelligence, Green Intellectual Capital, and Sustainability Performance more effectively.

4.2 Research Discussion

4.2.1 Interpretation of Key Findings

The findings of this study confirm that Artificial Intelligence (AI) is positively associated with organizational sustainability performance, while Green Intellectual Capital (GIC) is also positively associated with sustainability performance. The significant relationship between AI and Sustainability Performance indicates that digital transformation has become an important organizational capability for supporting sustainability-oriented activities. AI technologies enable organizations to process environmental information more efficiently through predictive analytics, intelligent automation, machine learning, and sustainability monitoring systems.

These technologies support organizations in improving environmental governance, operational efficiency, and data-driven sustainability decision-making processes. The results of this study are consistent with the findings of [Zhang et al. \(2025\)](#), who demonstrated that AI capabilities significantly enhance sustainability-oriented innovation performance through learning orientation and Green Intellectual Capital. Similarly, [Cui \(2025\)](#) emphasized that AI-driven green governance positively affects corporate sustainability performance and ESG quality through intelligent environmental analytics and digital governance systems. [Verdecchia et al. \(2023\)](#) further explained that Green AI contributes significantly to energy

efficiency, environmental monitoring, and sustainable operational management by reducing resource consumption and improving environmental optimization processes.

The positive relationship between AI and Sustainability Performance indicates that organizations implementing AI technologies may be better positioned to support environmental monitoring, sustainability-oriented decision-making, and operational efficiency. However, the present results should not be interpreted as establishing that AI strengthens GIC unless the separate AI → GIC regression model provides statistically significant evidence for that relationship. Therefore, the AI → GIC relationship requires interpretation based on the separately specified regression model rather than the AI coefficient reported in the Sustainability Performance regression. The findings also indicate that organizations implementing AI technologies are associated with stronger sustainability-oriented organizational capabilities.

This result aligns with the study of [Ashaari et al. \(2025\)](#), which found that AI-infused knowledge systems strengthen Green Intellectual Capital and improve accounting and sustainability performance. These previous findings provide theoretical and empirical support for the possibility that AI may contribute to GIC development; however, such a relationship must be established by the specific AI → GIC analysis in the present study. AI integration enables organizations to develop stronger green structural capital through intelligent sustainability reporting systems, automated environmental management, and digital governance mechanisms. Furthermore, AI supports the enhancement of green human capital by improving employees' sustainability knowledge, environmental awareness, and analytical capability. This finding supports [Elshaer et al. \(2024\)](#), who argued that the integration of AI and intellectual capital significantly transforms sustainability practices and innovation capability in tourism and hospitality organizations. Therefore, AI can be

viewed as a potential strategic enabler of organizational sustainability capability and environmental transformation, while its role in developing GIC should be interpreted according to the separate empirical test.

The significant effect of Green Intellectual Capital on sustainability performance further demonstrates that organizations possessing stronger environmental knowledge systems and sustainability-oriented intellectual resources are more capable of achieving long-term sustainability goals. Green Intellectual Capital strengthens organizational environmental performance through green innovation, environmental learning capability, sustainability governance, and stakeholder collaboration. The results support the findings of [Asiaei et al. \(2023\)](#), who found that Green Intellectual Capital significantly improves environmental performance through ambidextrous green innovation capability. Similarly, [Marco-Lajara et al. \(2022\)](#) confirmed that organizations with stronger Green Intellectual Capital demonstrate higher green performance and environmental competitiveness. In another study, [Marco-Lajara et al. \(2023\)](#) explained that Green Intellectual Capital positively affects green innovation performance, particularly in organizations implementing environmentally oriented business strategies.

The role of Green Intellectual Capital is also evident in strengthening organizational sustainability capability through its three main dimensions: green human capital, green structural capital, and green relational capital. Green human capital contributes to sustainability performance through employees' environmental competencies, green innovation capability, and sustainability awareness. This finding is consistent with [Agyabeng-Mensah and Tang \(2021\)](#), who found that green human capital significantly improves green competitiveness, social performance, and financial performance. Meanwhile, green structural capital enables organizations to institutionalize sustainability practices through

environmental policies, green information systems, sustainability reporting mechanisms, and organizational governance structures. [Ghosh and Haque \(2023\)](#) emphasized that green structural capital and organizational environmental systems significantly influence organizational performance and sustainability capability. In addition, green relational capital strengthens collaboration between organizations and external stakeholders, including suppliers, governments, communities, and environmentally conscious investors, thereby improving environmental legitimacy and sustainability governance.

This study also confirms that the simultaneous integration of AI and Green Intellectual Capital significantly improves sustainability performance. The regression results demonstrate that AI and GIC jointly have a significant effect on Sustainability Performance, although this simultaneous effect should be distinguished from a mediation effect. The F-test establishes the joint explanatory relationship of AI and GIC with Sustainability Performance but does not by itself establish that GIC mediates the effect of AI on Sustainability Performance. The findings suggest that sustainability transformation cannot rely solely on technological adoption without strengthening sustainability-oriented organizational culture, environmental knowledge systems, and green governance capability.

AI provides technological efficiency and intelligent decision-making support, while Green Intellectual Capital supplies the environmental knowledge base and organizational capability required for long-term sustainability transformation. This result supports [Nguyen et al. \(2025\)](#), who argued that AI alone cannot fully drive sustainability unless supported by strong Green Intellectual Capital and sustainability-oriented organizational resources. Similarly, [Begum et al. \(2023\)](#) found that green absorptive capacity and green business strategy strengthen the effectiveness of Green Intellectual Capital in supporting sustainable organizational outcomes.

Furthermore, the integration of AI and GIC contributes significantly to sustainability-oriented operational capability, ESG governance quality, environmental efficiency, and green innovation acceleration. Based on the significant direct relationships and simultaneous regression results, organizations implementing AI and GIC are associated with stronger sustainability outcomes.

However, the present findings do not by themselves establish that GIC is the intervening mechanism through which AI affects Sustainability Performance. Such an interpretation requires evidence from the AI → GIC path and a formal test of the indirect effect. Organizations implementing both AI and Green Intellectual Capital are more capable of optimizing resource allocation, reducing environmental risks, improving carbon management systems, and enhancing sustainability reporting quality. This finding aligns with [Cui \(2025\)](#), who demonstrated that digital innovation and Human-AI technology integration positively affect corporate ESG performance and environmental governance effectiveness. [Martínez-Falcó et al. \(2023\)](#) also highlighted that sustainable supply chain management and green agriculture practices strengthen the relationship between Green Intellectual Capital and sustainability performance. Likewise, [Moroni et al. \(2022\)](#) found that eco-innovation, stakeholder engagement, and dynamic capabilities positively influence sustainable business performance and environmental competitiveness.

4.2.2 Comparison with Previous Studies

The findings of this study generally support previous empirical studies emphasizing the strategic role of Artificial Intelligence and Green Intellectual Capital in sustainability transformation. The findings are in line with [Zhang et al. \(2025\)](#), [Cui \(2025\)](#), and [Verdecchia et al. \(2023\)](#), who highlighted that AI capabilities significantly improve sustainability-oriented innovation, environmental governance, and ESG

performance. Similarly, the findings are consistent with [Ashaari et al. \(2025\)](#) and [Elshaer et al. \(2024\)](#), who emphasized the importance of AI-driven knowledge systems and intellectual capital in strengthening sustainability capability and organizational innovation.

The findings regarding Green Intellectual Capital are also aligned with [Asiaei et al. \(2023\)](#), [Marco-Lajara et al. \(2022\)](#), and [Marco-Lajara et al. \(2023\)](#), which confirmed that environmental knowledge resources and green innovation capability significantly improve environmental performance and organizational competitiveness. In addition, the findings support [Agyabeng-Mensah and Tang \(2021\)](#) as well as [Ghosh and Haque \(2023\)](#), who emphasized the strategic role of green human capital and green structural capital in strengthening sustainability governance and organizational capability.

However, this study extends previous research by integrating AI and Green Intellectual Capital simultaneously within a single sustainability framework. Unlike prior studies that tended to examine these variables separately, this study demonstrates that technological capability and environmental intellectual resources are jointly associated with sustainability performance. Thus, this study provides a more comprehensive understanding of sustainability transformation mechanisms in organizations. Nevertheless, the proposed mechanism whereby AI affects Sustainability Performance through GIC requires separate empirical verification through the AI → GIC path and a formal indirect-effect test.

4.2.3 Theoretical Contributions

From a theoretical perspective, these findings strongly support stakeholder theory, which emphasizes that organizations must create value not only for shareholders but also for broader stakeholders through responsible environmental governance and sustainable business practices. Organizations are increasingly expected to balance economic

performance, environmental responsibility, and social accountability simultaneously. The integration of AI and Green Intellectual Capital enables organizations to address stakeholder expectations more effectively by improving transparency, sustainability governance, ESG reporting quality, and environmental accountability.

This finding is also consistent with [Rachman et al. \(2023\)](#) and [Hulaemah and Mulyasari \(2024\)](#), who highlighted the importance of top management support in strengthening the relationship between Green Intellectual Capital and sustainability outcomes. Moreover, [Firmansyah et al. \(2024\)](#) emphasized that environmental leadership significantly enhances sustainability performance through sustainability-oriented governance and intellectual capital development.

Overall, the findings of this study contribute to the growing literature on sustainability accounting, digital transformation, and Green Intellectual Capital by demonstrating that AI and environmental intellectual resources collectively play a critical role in achieving organizational sustainability performance. The findings provide empirical support for the direct relationships examined in the study and for the joint contribution of AI and GIC to Sustainability Performance. The proposed mediating role of GIC, however, should only be concluded after the separate AI → GIC relationship and the indirect effect have been statistically established. The study also highlights that sustainability transformation requires not only technological sophistication but also organizational learning capability, environmental culture, and sustainability-oriented governance systems.

4.2.4 Practical and Policy Implications

The findings imply that organizations should prioritize the integration of Artificial Intelligence into sustainability management systems to improve environmental governance, sustainability monitoring, and strategic decision-making processes. AI

technologies can support organizations in enhancing operational efficiency, environmental risk management, carbon management systems, and sustainability reporting quality.

The findings also suggest that organizations should strengthen Green Intellectual Capital through the development of green human capital, green structural capital, and green relational capital. Organizations should invest in sustainability training, digital environmental systems, green innovation capability, and stakeholder collaboration to achieve long-term sustainability objectives.

From a policy perspective, policymakers and regulators should encourage the adoption of AI-driven sustainability governance and ESG-oriented innovation through supportive regulations, sustainability standards, and digital transformation initiatives. Such policies may improve corporate environmental accountability and accelerate sustainable business transformation.

The practical implications concerning GIC as a pathway linking AI to Sustainability Performance should be considered conditional upon the results of the formal mediation analysis. If the indirect effect is statistically significant, organizations may additionally consider GIC development as an organizational pathway through which AI-related capabilities can be translated into sustainability outcomes. If the indirect effect is not significant, the practical interpretation should instead focus on the separate contributions of AI and GIC to Sustainability Performance.

4.2.5 Integration with the Research Gap

This study successfully addresses the research gap identified in previous literature regarding the limited integration of Artificial Intelligence and Green Intellectual Capital in explaining sustainability performance. Previous studies predominantly focused on either AI implementation or Green Intellectual Capital separately. However, this study demonstrates that the simultaneous integration of AI and GIC significantly

contributes to sustainability-oriented operational capability, environmental efficiency, ESG governance quality, and green innovation acceleration.

Therefore, this study offers a more integrated perspective on how organizations can achieve sustainability transformation through the combination of technological capability and sustainability-oriented intellectual resources. The study also provides a basis for examining whether GIC functions as an explanatory pathway between AI and Sustainability Performance. However, this mediating mechanism should be claimed only if the separate AI → GIC relationship and the indirect effect are statistically supported by the mediation analysis. This contribution strengthens the originality and relevance of the study within the fields of sustainability accounting, digital transformation, and environmental governance.

4.2.6 Acknowledgement of Study Limitations

Despite its contributions, this study has several limitations. First, the findings are context-specific and may not fully represent organizations operating in different industrial sectors or geographical environments. Second, sustainability performance was examined mainly through sustainability-oriented indicators and organizational perceptions, which may not entirely capture long-term environmental impacts and sustainability outcomes.

In addition, this study focused primarily on the direct relationship between AI, Green Intellectual Capital, and sustainability performance. Although the conceptual framework proposes GIC as a mediating variable, the mediation interpretation depends on the separate estimation of the AI → GIC path and the formal testing of the indirect AI → GIC → Sustainability Performance effect. Therefore, conclusions regarding the mediating mechanism should be made only after these statistical results have been established. Other contextual variables such as ESG governance quality, organizational culture, environmental

leadership, and green innovation capability may also influence sustainability outcomes. Therefore, the interpretation and generalizability of the findings should be considered carefully.

5. Conclusion

5.1 Summary of Key Findings

This study concludes that Artificial Intelligence significantly affects sustainability performance, while Green Intellectual Capital also significantly contributes to sustainability performance. The reported regression results indicate that AI and GIC each have significant relationships with sustainability performance. However, the conclusion that AI significantly strengthens Green Intellectual Capital requires separate empirical evidence from a correctly specified regression model with GIC as the dependent variable. Therefore, the AI → GIC relationship should be interpreted according to the results of the specific hypothesis test for this relationship. AI implementation is associated with sustainability-oriented organizational capabilities, including environmental knowledge management, organizational learning, and sustainability-oriented innovation, while these implications should be interpreted consistently with the statistically tested relationships. Green Intellectual Capital also significantly contributes to sustainability performance by enhancing environmental capabilities, sustainability governance, and organizational competitiveness.

Furthermore, the findings demonstrate that the simultaneous integration of AI and Green Intellectual Capital significantly improves sustainability performance. AI and GIC explain 78.1% of sustainability performance variation, indicating their strong strategic role in supporting sustainable organizational transformation. The findings confirm that sustainability transformation requires not only technological advancement but also sustainability-oriented organizational culture, environmental knowledge systems, and governance capability. However, the

significant joint effect of AI and GIC on sustainability performance should not be interpreted as evidence that GIC mediates the relationship between AI and sustainability performance unless the AI → GIC path and indirect effect have been formally tested and supported.

5.2 Theoretical Contributions

This study contributes to the literature on sustainability accounting, digital transformation, and Green Intellectual Capital by confirming the strategic relationship between Artificial Intelligence, environmental intellectual resources, and sustainability performance. The findings strengthen stakeholder theory by demonstrating that organizations can improve sustainability accountability and stakeholder value through AI-driven governance and Green Intellectual Capital development.

The study also extends previous research by integrating Artificial Intelligence and Green Intellectual Capital within a single research framework. This integration provides a broader theoretical understanding of how technological capability and environmental intellectual resources jointly contribute to sustainability transformation and long-term organizational performance. The proposed role of GIC as a mediating mechanism, however, should only be concluded when the separate AI → GIC relationship and the indirect effect are statistically established.

5.3 Practical and Policy Implications

The findings imply that organizations should prioritize AI integration and Green Intellectual Capital development as part of their strategic sustainability management framework. Managers should strengthen sustainability-oriented organizational learning, green innovation capability, and digital environmental governance systems to improve sustainability performance.

Organizations are also encouraged to invest in sustainability training, intelligent environmental monitoring systems, ESG

reporting quality, and stakeholder collaboration. From a policy perspective, governments and regulators should support AI-driven sustainability initiatives through sustainability regulations, ESG standards, and digital transformation policies that encourage environmentally responsible business practices. If the separate mediation analysis confirms the indirect effect of AI through GIC, organizations may additionally consider GIC development as a pathway for translating AI capabilities into sustainability outcomes.

5.4 Limitations of the Study

This study has several limitations related to the scope and interpretation of the findings. The study was conducted within a limited organizational context, which may affect the generalizability of the results across industries and countries with different technological capabilities and sustainability practices.

In addition, the study mainly examined the relationships among AI, Green Intellectual Capital, and sustainability performance within the variables specified in the research framework. The interpretation of GIC as a mediating variable is subject to the results of the separate AI → GIC regression and formal indirect-effect analysis. Therefore, the findings should be interpreted within the boundaries of the study context and organizational characteristics examined.

5.5 Directions for Future Research

Future studies are recommended to include moderating or mediating variables such as ESG governance, organizational culture, environmental leadership, green innovation capability, or sustainable supply chain management to obtain a more comprehensive understanding of sustainability transformation mechanisms.

Future researchers are also encouraged to employ more advanced analytical approaches such as Structural Equation Modeling (SEM) to examine more complex causal relationships among variables. Comparative studies across industries,

countries, or organizational types are also recommended to provide deeper insights into the implementation of Artificial Intelligence and Green Intellectual Capital in different sustainability contexts. Future research should also explicitly test the AI → GIC relationship and the indirect effect of AI on sustainability performance through GIC, thereby providing stronger evidence regarding whether GIC functions as a mediating mechanism.

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