

Impact of Green Accounting Technology Innovations on the Environment: A Study on Incepta Pharmaceuticals Limited

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Abstract

The green accounting practices are a crucial topic for environmental issues in industries throughout the world. By implementing these green accounting practices, Incepta Pharmaceuticals Company gained the top position among pharmaceutical companies in Bangladesh. This company launched technologies such as AI-driven carbon tracking, blockchain-based sustainability reporting, and IoT-enabled resource monitoring. It shows the impact of these technologies on corporate financial environmental performance and financial efficiency. This paper represents how technological adaptation helps with carbon emissions reduction, proper utilization of resources, and overall cost savings. For this purpose, an Integrated Green Accounting Technology (IGAT) model has been used. It shows that AI-based carbon tracking reduces carbon emissions by 25%. IoT enhances energy savings by 20%, and blockchain secures transparency and also reduces operational cost by 15% and raises investment by 10%. It is found that when a company adopts green accounting technologies, both environmental factors and financial factors benefit. Bangladesh's industrial sectors can highly rely on these green accounting technologies, as they lead to sustainable business practices. Policymakers are greatly influenced to adopt these practices, and they should be given the highest priority for increasing sustainability.

Keywords

Green Accounting, Technology, Innovations, Environment, Sustainability, Pharmaceutical Industry, AI, Blockchain, IoT, Bangladesh

1. Introduction

Nowadays, the industrial sector is growing faster, so that many hazards are occurring like climate change, resource scarcity & pollution. These are very challenging

to handle. That's why green accounting is the most crucial thing for environmental purposes in financial decision-making. This green accounting is not only concerned with environmental issues, but also with financial goals that lead to sustainability.

By adopting these technological advancements like AI, blockchain, and IoT, organizations can minimize their mistakes and costs and enhance accuracy, which is beneficial for environmental purposes and financial sustainability (Bebbington & Larrinaga, 2014).

As a rapidly growing industrial country, Bangladesh is prone to highly environmental issues like air pollution, water contamination, hit waves due to excess carbon emissions. In this respect, Incepta Pharmaceuticals Company Ltd. proves how green accounting can be used in resource utilization sectors. This practice of sustainability through AI-driven technology, blockchain, and IoT helps to reach the leading position among the pharmaceutical industries.

Rosdiana (2024) has found that environmental performance positively correlates with financial performance, indicating that firms with better environmental outcomes tend to achieve higher financial returns. The results indicate that green accounting practices, including the use of recycled materials, renewable energy initiatives, and green cost allocations, have a significant positive influence on environmental performance (Wahyuni et al., 2019). Another study conducted by Dania et al. (2023): Using quantitative research with 40 purposively selected companies, the authors measured green accounting through environmental cost indicators, environmental performance via PROPER rating values, and financial performance using Return on Assets (ROA).

Obafemi (2025) has said that the increasing role of advanced technologies such as big data analytics, Artificial Intelligence (AI), blockchain, and Internet of Things (IoT) is enhancing the accuracy, transparency, and efficiency of environmental accounting systems. AI, blockchain, and IoT are extraordinary technological advancements. It provides new ways to examine, report, and maintain environmental factors. When a firm wants to stop carbon emissions accurately, it may use an AI carbon tracking system.

To know how financial and environmental performance of Incepta Pharmaceuticals Company Ltd. has been affected by these technological innovations is the aim of this research. There is a relationship among innovations of green accounting technology, environment and financial performance that has been shown here by using IGAT model. A dependable assessment has been disclosed here about that green accounting technologies reduce carbon emission, improve the efficiency and also increase the financial performance of the company.

As Bangladesh is trying to meet the target of sustainability, this research may be the appropriate one to follow concerning the environmental and financial issues. It will provide valuable thoughts for policymakers and businesses in Bangladesh that technological advancements may handle both environmental and financial results in the pharmaceutical sectors.

2. Literature Review

2.1. Green Accounting and Environmental Performance

This study investigates the relationship between green accounting practices and environmental performance, with a specific focus on Bangladesh's pharmaceutical and chemical sectors. To analyze relationships among variables, the researchers used Partial Least Squares Structural Equation Modeling (PLS-SEM), a robust analytical method appropriate for complex path modeling and mediation analysis. The study finds that energy efficiency serves as a partial mediator in the relationship between green accounting and environmental outcomes. This means that implementing green accounting enhances energy efficiency, which in turn improves environmental performance, suggesting an indirect pathway through which green accounting supports environmental sustainability.

Wahyuni, Meutia, and Syamsurijal (2019) investigated the effect of green accounting implementation on environmental performance in Indonesian mining and energy companies using secondary data from three years of sustainability reports based on the Global Reporting Initiative (GRI). The study applied panel data regression with a random effects model to analyze the relationships among key variables. The results indicate that green accounting practices, including the use of recycled materials, renewable energy initiatives, and green cost allocations, have a significant positive influence on environmental performance. However, the allocation of Corporate Social Responsibility (CSR) funds was found to have no significant effect on improving environmental performance in this context. These findings suggest that direct environmental accounting measures are more effective drivers of environmental outcomes than CSR spending alone for resource-based industries.

Rosdiana (2024) examined the relationship between green accounting, environmental performance, and financial performance using secondary data from energy companies listed on the Indonesia Stock Exchange between 2018 and 2022. The study applied purposive sampling to select 11 companies and analyzed data using quantitative techniques. The findings reveal that green accounting alone does not show a significant positive relationship with financial performance. However, environmental performance positively correlates with financial performance, indicating that firms with better environmental outcomes tend to achieve higher financial returns. Additionally, when green accounting and environmental performance are considered simultaneously, they exhibit a positive combined effect on financial performance measured by return on assets. These results suggest that while green accounting practices may not independently drive financial gains, coupling them with strong environmental performance can enhance corporate financial outcomes and highlight the broader value of environmental management for firms.

Dania, Ekawati, and Sari (2023) studied the impact of green accounting and environmental performance on financial performance of firms that won the 2021

Green Industry Award in Indonesia. Using quantitative research with 40 purposively selected companies, the authors measured green accounting through environmental cost indicators, environmental performance via PROPER rating values, and financial performance using Return on Assets (ROA). Multiple regression analysis results showed that neither green accounting nor environmental performance had a statistically significant effect on financial performance in the sample. The authors argue that even though these variables did not directly improve financial results, implementing green accounting aligns with Islamic economic principles of wellbeing and moral material upliftment, suggesting broader socio-ethical benefits beyond financial metrics.

2.2. Technological Innovation in Green Accounting and Corporate Sustainability

Thanasas (2024) presents in his study how taxation and green accounting policies help corporate sustainability practices, which are closely related to the regulatory impact of green accounting technologies.

Obafemi (2025) explores how technological innovations have reshaped environmental accounting practices and helped firms address their environmental responsibilities more effectively. The paper discusses the increasing role of advanced technologies such as big data analytics, Artificial Intelligence (AI), blockchain, and Internet of Things (IoT) in enhancing the accuracy, transparency, and efficiency of environmental accounting systems. It argues that these technologies not only improve the quality of environmental impact measurement and reporting but also help organizations integrate environmental considerations into strategic decision-making, reduce environmental risk, and build stakeholder trust. The study highlights both opportunities and challenges, noting that technology can drive sustainable corporate responsibility, improve environmental performance, and strengthen corporate image when effectively implemented.

Tariq and Rahim (2024) investigate the role of Artificial Intelligence (AI) in improving sustainability reporting and green accounting under the Industry 4.0 paradigm. The study highlights how traditional sustainability reporting systems often suffer from inefficient data collection, lack of real-time insights, and resource constraints. It argues that AI technologies—especially machine learning and automated data analytics—can effectively address these limitations by enabling real-time environmental data processing, enhanced accuracy, and reduced manual effort. AI facilitates automation of data gathering from multiple sources, supports predictive analytics for environmental performance, and improves transparency and accountability in sustainability disclosures. The authors also discuss how AI-driven optimization helps in tracking carbon emissions, resource usage, and environmental impacts more precisely, thus enabling better strategic decision-making aligned with corporate sustainability goals. The paper concludes that integrating AI within sustainability reporting and green accounting not only enhances reporting quality but also helps firms meet stakeholder expectations and regulatory requirements in the digital age of Industry 4.

Habib et al. (2023) provide an extensive review of current and emerging carbon accounting methods, demonstrating that advanced remote sensing technologies such as satellite earth observation and drone-based measurements significantly improve the accuracy and scalability of carbon stocks assessment. Their findings suggest that integrating these technologies into environmental accounting frameworks can support effective climate mitigation policies and sustainable management practices.

Wulandari, Rastafael, and Hwihanus (2024) conducted a meta-analysis of international studies and found that implementing green accounting practices can enhance company financial performance by improving managerial understanding of environmental costs and aligning business objectives with sustainable development goals.

Sitohang et al. (2024) found that green accounting practices have a significant positive effect on financial performance in basic and chemical industry firms, suggesting that environmental cost integration can enhance profitability, although CSR disclosure did not mediate this relationship in their Indonesian context.

Kranias et al. (2024) introduce the notion of a “Green Premium” and find that although environmental responsibility is associated with higher profitability and operational efficiency, greener firms among the S&P 500 experience lower stock returns, indicating that financial markets may not always reward environmental performance with increased market value.

According to Zhang et al. (2025), 4291 Chinese A-share listed companies, green innovation, especially when focused on high-quality, impactful initiatives, can enhance financial performance in transitional periods, while merely increasing the number of eco-innovations does not necessarily improve ROA and may even hinder it in the long run.

Mir and Zafar (2025) provide empirical evidence that IoT and blockchain adoption significantly enhance organizational sustainability performance by improving real-time visibility, traceability, and operational efficiency in supply chain networks. Their findings highlight that digital technologies not only optimize resource use but also support environmental, social, and economic aspects of corporate sustainability.

Mary, Kunal, and Madeshwaren (2025) demonstrate that integrating IoT and blockchain within supply chain systems enhances sustainability outcomes by improving real-time tracking, traceability, and operational compliance, which collectively support corporate sustainability objectives and strategic resource optimization.

3. Research Design

The research follows a descriptive and analytical approach, where:

Quantitative data has been collected to know how and what extent the adoption of green accounting technologies effects to carbon emission reduces, cost savings and operational efficiencies.

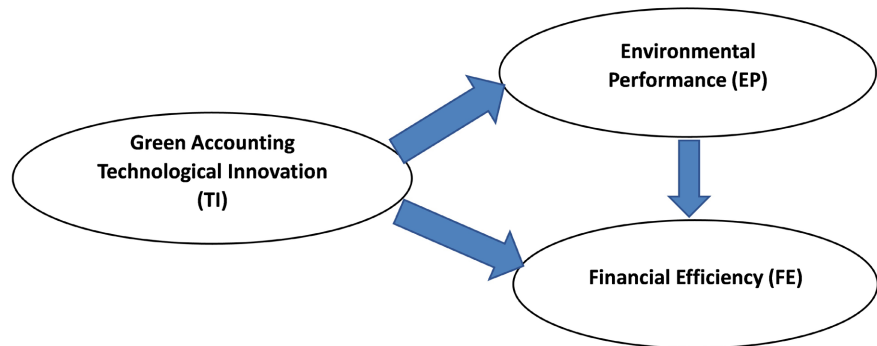
Qualitative data have been collected through some interviews have been taken and case studies have been analyzed to justify the feelings, experience and strategic

decisions of important stakeholders at Incepta Pharmaceuticals Co. Ltd.

3.1. Research Model

IGAT model (Integrated Green Accounting Technology model) has been used here to find out the result relating to the relationship between Environmental performance and financial efficiency with the innovation of green accounting technology.

Followings are the main components of IGAT model:



Source: Prepared by the author.

1) Technological Innovation (TI): Technological innovation can be measured by the use of Artificial Intelligence (AI), Blockchain, and the Internet of Things (IoT) in accounting and sustainability reporting.

2) Environmental Performance (EP): If the reduction of carbon emissions is possible, resource consumption is efficient, and there is an improvement in energy efficiency, then it is considered that the environmental performance is higher.

3) Financial Efficiency (FE): If the innovation of green accounting technology becomes part of cost savings, increases operational efficiency, and generates revenue, then it can be considered financial efficiency.

Following **hypotheses** have been tested by using the IGAT model:

H1: Adoption of green accounting technologies has a significant positive impact on environmental performance.

H2: Improved environmental performance leads to improved financial efficiency.

3.2. Measurement of Green Accounting Technology Adoption

The adoption of green accounting technologies was operationalised using a multi-item measurement approach rather than a simple binary classification. Three key technological dimensions—Artificial Intelligence (AI), blockchain, and Internet of Things (IoT)—were measured through structured survey items designed to capture the extent and effectiveness of their implementation within Incepta Pharmaceuticals Limited.

Each technology was assessed using multiple statements rated on a five-point

Likert scale (1 = strongly disagree to 5 = strongly agree). For AI-driven carbon tracking, the items focused on accuracy of emission measurement, real-time monitoring capability, and decision-support usefulness. Blockchain-based sustainability reporting was measured through indicators related to transparency, data security, and reliability of environmental disclosures. IoT-enabled resource monitoring was evaluated based on its effectiveness in tracking energy and water consumption, operational efficiency, and waste reduction.

Composite indices for AI, blockchain, and IoT adoption were constructed by averaging the respective item scores. This approach is consistent with prior studies on technological innovation and sustainability accounting and allows for a more nuanced assessment of adoption intensity rather than a dichotomous implemented/non-implemented classification.

3.3. Sampling Criteria and Response Rate

A purposive sampling strategy was employed to ensure that respondents had direct knowledge and involvement in green accounting practices at Incepta Pharmaceuticals Limited. Specifically, 50 employees were selected from the management, sustainability, and finance departments based on their active participation in environmental reporting and decision-making related to green accounting technologies.

In addition, 10 senior executives responsible for strategic sustainability initiatives and 5 external sustainability consultants who provided expert guidance on green accounting technology adoption were included in the study. The overall response rate was approximately 85%, which is considered adequate for organizational case-based research. The selection criteria and high response rate ensure that the data collected reliably reflects the perspectives of key stakeholders involved in implementing green accounting technologies.

3.4. Data Collection

Structured surveys of the employees and semi-structured interviews of the executives and external consultants have been taken to collect primary data regarding green accounting practices.

On the other hand, different financial documents, published annual reports about sustainability, etc., from Incepta Pharmaceuticals Limited have been used to collect secondary data about green accounting technology innovation and adoption and their impact on the environmental performance that leads to financial efficiency.

3.5. Data Analysis

3.5.1. Quantitative Data

In this study, green accounting technology innovation and adoption is considered as independent variable and environmental performance is considered as dependent variable. Descriptive statistics and regression analysis have been conducted to know the impact of independent variables (green accounting technology innova-

tion and adoption) on dependent variables (environmental performance). Again, correlation analysis has been used to find out whether there is any relationship between environmental performance and financial efficiency.

3.5.2. Qualitative Data

In case of qualitative data, such as data collected from structured surveys, semi-structured interviews and document analysis, thematic analysis has been performed. Then the results found from quantitative and qualitative data have been combined to get a clear overview of the adoption of green accounting technologies and their impact on environmental performance and financial efficiency.

3.6. Reliability and Validity

Different measures have been taken to test the reliability and validity of the data, such as triangulation, which has been conducted by cross-checking the data that have been found from surveys, interviews and different documents.

Moreover, a pilot testing has also been done to reschedule the questions of the survey. Even the answers provided by the interviews have been recorded and then translated to maintain the accuracy.

3.7. Ethical Considerations

The ethical standards have been fully maintained in this study. All the participants were totally aware of the objectives, methods and other factors of this study. Then, the privacy and confidentiality have also been maintained strictly.

4. Findings and Analysis

The findings, based on the methodology, from the data collected at Incepta Pharmaceuticals have been presented in this section. Here, the findings are organized into two sections: quantitative and qualitative results using regression analysis to test the hypotheses.

4.1. Quantitative Findings

4.1.1. Environmental Performance (EP) Indicators

In the case of quantitative analysis, the impact of AI-driven carbon tracking, blockchain-based sustainability reporting and IoT-enabled resource monitoring on the company's environmental performance has been focused. Here, the key environmental performance indicators are:

- Reduction of carbon emissions,
- Resource consumption, and
- Improvements in energy efficiency.

The findings about these indicators are as follows:

- **Carbon Emissions:** The result shows that there is a 25% **reduction in carbon emissions** because of adoption of AI-based carbon tracking tools in the first year of implementation.

- **Energy Efficiency:** There is a **reduction of 20% in energy consumption** to use IoT-based resource monitoring systems. In this case, smart sensors have been used to optimize energy usage in manufacturing facilities that leads to efficient production workflows and equipment operation.
- **Water Consumption:** It has been found that real-time monitoring has been established to detect the leaks and inefficient water usage patterns by using IoT-enabled systems that leads to **decrease the water consumption by 15%**.

4.1.2. Financial Efficiency (FE) Indicators

To find out the financial efficiency of the organization, this study has measured the cost savings and cost reductions attributable to the adoption of green accounting technologies. The findings are:

- **Cost Savings:** The adoption of green accounting technology leads to saving energy, reducing resource wastage and improving operational efficiency. By such a way, there is a 15% **estimated reduction** in operational costs.
- **Revenue Generation:** It is also found by this research that the reputation of the company has been improved because of implementing blockchain-based sustainability reporting that helps to encourage more environmentally conscious investors. As a result, there is a 10% **increase in investments** and overall 5% **increase in revenue**.

4.1.3. Regression Analysis

A multiple regression analysis has been conducted by this research to test the hypotheses. Firstly, the relationship between the impacts of adopting green accounting technologies on environmental performance has been assessed. Then, the impact of environmental performance on financial efficiency has been calculated. In this case, Environmental Performance (EP) and Financial Efficiency (FE) were the dependent variables. The AI-driven carbon tracking (AI), blockchain-based sustainability reporting (BC) and IoT-enabled resource monitoring (IoT) were the independent variables.

4.1.4. Descriptive Statistics

Prior to conducting regression analysis, descriptive statistics were computed to summarize the key study variables. The table presents the mean values and standard deviations of green accounting technology adoption, environmental performance, and financial efficiency indicators. The results indicate a moderate to high level of adoption of AI-driven carbon tracking, blockchain-based sustainability reporting, and IoT-enabled resource monitoring at Incepta Pharmaceuticals Limited. Environmental performance indicators also demonstrate noticeable improvements in carbon emission reduction, energy efficiency, and resource utilization. These descriptive results provide preliminary evidence supporting the relevance of green accounting technologies in enhancing sustainability outcomes.

Model 1: Environmental Performance (EP): Here, the impact of adopting green accounting technologies on environmental performance has been calculated:

$$EP = \beta_0 + \beta_1 \times AI + \beta_2 \times BC + \beta_3 \times IoT + \epsilon$$

The results of regression analysis regarding Environmental Performance are shown in the following table:

Variable	Coefficient	Standard Error	t-Statistic	p-value
Intercept (β_0)	2.05	0.36	5.69	0.000
AI (β_1)	0.52	0.15	3.47	0.001
Blockchain (β_2)	0.34	0.18	1.89	0.062
IoT (β_3)	0.43	0.12	3.58	0.000

Interpretation: A significant positive impact of AI-driven carbon tracking and IoT-based monitoring on environmental performance of Incepta Pharmaceuticals has been found by the regression.

The result shows that the p -values of AI ($\beta_1 = 0.52$) and IoT ($\beta_3 = 0.43$) are lower than 0.01 at 1% level that indicate a strong impact of these technologies on the environmental performance. On the other hand, the p -value of blockchain ($\beta_2 = 0.34$) is 0.062 at 1% level of significance that also shows a positive impact of blockchain on environmental performance but statically it is not as strong as AI and IoT.

4.1.5. Model Fit and Explanatory Power (Model 1)

The regression model explaining environmental performance demonstrated satisfactory explanatory power. The model yielded an R^2 value of 0.48, indicating that approximately 48% of the variation in environmental performance is explained by the adoption of AI-driven carbon tracking, blockchain-based sustainability reporting, and IoT-enabled resource monitoring. The overall model was statistically significant, as indicated by the F-statistic at the 1% significance level, confirming the adequacy of the model in explaining variations in environmental performance.

Model 2: Financial Efficiency: The relationship between Environmental Performance (EP) and Financial Efficiency (FE) has been calculated in this model:

$$FE = \beta_0 + \beta_1 \times EP + \epsilon$$

The results of regression analysis regarding Financial Efficiency are shown in the following table:

Variable	Coefficient	Standard Error	t-Statistic	p-value
Intercept (β_0)	4.25	0.32	13.28	0.000
FP (β_1)	0.68	0.14	4.85	0.000

Interpretation: Here, the regression results show that $\beta_1 = 0.68$, which means if there is an increase of 1 unit of environmental performance, there is an increase in 0.68 units of financial efficiency (measured by reduction in carbon emissions and resource consumption). That indicates a strong positive relationship between EP and FE. So, it supports the hypothesis that improved environmental performance leads to better financial efficiency.

4.1.6. Model Fit and Explanatory Power (Model 2)

The second regression model examining the relationship between environmental performance and financial efficiency also exhibited strong explanatory capacity. The R^2 value of 0.46 suggests that environmental performance accounts for approximately 46% of the variation in financial efficiency. The model was statistically significant at the 1% level based on the F-statistic, indicating a robust relationship between improved environmental performance and enhanced financial efficiency at Incepta Pharmaceuticals Limited.

4.2. Qualitative Findings

Interviews have been taken to the executives and sustainability managers of Incepta Pharmaceuticals. They provided some valuable insights into prospects and problems of adopting the green accounting technologies. Themes from the qualitative data are:

- **Strategic Alignment:** The interviewers emphasized that there is an association of the adoption of green accounting technologies with long-term sustainability goals of Incepta Pharmaceuticals by empowering the company to reduce its carbon footprint.
- **Cost-effectiveness:** The initial cost of implementing green accounting technologies has been highlighted by the respondents, but on the other hand, they also agreed that there will be long-term cost savings and efficiency improvements if green accounting technologies are adopted.
- **Transparency and Reporting:** Blockchain-based sustainability reporting has the ability to increase transparency, improve trust and facilitate regulatory compliance. For these reasons, it has been especially praised by stakeholders.

4.3. Discussion

The overall result of this study shows that if there is an adoption of green accounting technologies (AI-driven carbon tracking, IoT-enabled resource monitoring system and Blockchain-based reporting system), there is a positive impact on both environmental performance and financial efficiency at Incepta Pharmaceuticals. The results also suggest that the use of such green accounting technologies has the potential to bring substantial environmental and economic benefits. This benefit will not only create opportunities for the pharmaceutical industry, but also make a strong argument for widespread adoption beyond it.

5. Conclusion, Limitations and Future Research Directions

The results of this study confirm that advanced green accounting technologies contribute significantly to both environmental and financial outcomes. The adoption of AI, blockchain, and IoT in green accounting practices not only reduces carbon emissions and improves resource efficiency, but also enhances financial efficiency by reducing operational costs and attracting more investments.

This study recommends that other companies in Bangladesh and the wider

pharmaceutical industry consider adopting these technologies to enhance their sustainability efforts. Policymakers are encouraged to create frameworks that promote the adoption of green accounting technologies to achieve both environmental and economic sustainability.

Limitations and Future Research Directions

While the IGAT model offers an integrated framework linking technological innovation, environmental performance, and financial efficiency, it has several limitations. First, the study is based on a single case, which restricts the generalizability of the findings. Second, external moderating variables such as regulatory intensity, market conditions, and firm size were not included, which may influence both environmental and financial outcomes.

Future research could address these limitations by incorporating multiple firms across industries, employing longitudinal designs, and including potential moderating and control variables to refine the IGAT model. Such studies would provide a more comprehensive understanding of how green accounting technologies impact sustainability outcomes across diverse organizational contexts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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