https://doi.org/10.65166/fh308y59

Journal of Enterprise Strategy & Management Innovation
Volume I, Issue 3, August 2026
ISSN: 3116-4277 (Online)
https://journal.ijhba.com/index.php/jesmi
https://slsipress.com

Influence of Innovation Investment on Operational Efficiency and Business Growth of Environmental Protection Companies: Basis for Improved Business Performance Framework

Guan Haizhong
Graduate School, Lyceum of the Philippines University - Batangas

Abstract

Innovation investment is increasingly important to environmental protection companies seeking to improve organizational efficiency, sustain competitiveness, and respond to environmental and technological demands. This study examined the influence of innovation investment on the operational efficiency and business growth of environmental protection companies in Shandong Province, China, as the basis for developing an improved business performance framework. A quantitative descriptive-correlational design was employed. Data were collected through a researcher-developed questionnaire administered to 400 officers from five environmental protection companies who had knowledge of their organizations' strategic, financial, and operational activities. Descriptive statistics, Spearman's rho correlation, and multiple regression analysis were used to analyze the data. The findings indicated that the companies generally practiced innovation investment through research and development, technology adoption, and green innovation initiatives. Respondents likewise reported favorable operational efficiency in resource utilization, process optimization, and cost reduction, as well as favorable business growth in revenue turnover, market share expansion, and customer base growth. Innovation investment was positively and significantly associated with both operational efficiency and business growth. Research and development, technology adoption, and green innovation initiatives also significantly predicted the two organizational outcomes, with green innovation initiatives emerging as the strongest predictor. Operational efficiency was further positively associated with business growth. The findings support an integrated framework in which sustained investment in research, technological capability, and environmentally oriented innovation strengthens operational effectiveness and contributes to organizational growth. Environmental protection companies may therefore align innovation investments with efficiency, sustainability, and long-term growth priorities.

Keywords: *innovation investment; operational efficiency; business growth; green innovation; technology adoption; environmental protection companies.*

1. Introduction

Innovation has become a strategic requirement for firms operating in industries shaped by rapid technological change, environmental regulation, and increasing expectations for sustainable business practices. This requirement is especially pronounced among environmental protection companies, whose operations must simultaneously address commercial performance and ecological responsibility. Such companies are expected to develop technologies, processes, and services that reduce environmental harm while maintaining organizational efficiency, market competitiveness, and financial viability. In this context, investment in innovation is not merely a discretionary organizational activity but a central component of long-term business strategy.

Innovation investment generally involves the allocation of financial, technological, and organizational resources to activities intended to improve products, services, operational systems, and environmental performance. Within environmental protection companies, three areas are particularly relevant: research and development, technology adoption, and green innovation initiatives. Research and development enables firms to generate new knowledge, improve existing technologies, and develop solutions that respond to environmental and market demands. Technology adoption allows organizations to modernize their operations through digitalization, automation, advanced equipment, and data-driven decision-making. Green innovation initiatives focus on technologies, processes, and practices that reduce environmental impact while supporting organizational competitiveness.

The strategic value of these investments is increasingly evident as firms encounter stronger environmental regulations and rising stakeholder expectations. Environmental regulation, environmental, social, and governance performance, and

technological innovation have been associated with stronger enterprise resilience under green development conditions (Wu & Tham, 2023). Environmental regulations may also stimulate innovation, improve intellectual capital, and contribute to environmental and economic performance (Trevlopoulos et al., 2021). These findings indicate that regulatory and sustainability pressures need not function solely as operational constraints. When supported by appropriate innovation investments, they may encourage technological development, organizational learning, and strategic renewal.

Green technology innovation is particularly important in industries where environmental performance is directly connected to organizational legitimacy and competitiveness. Investment in environmentally oriented technologies may improve productivity, support resource conservation, and reduce the environmental consequences of business operations. Mukhtar et al. (2025) found that green technology innovation and organizational innovation capabilities contribute to sustainability performance among manufacturing firms. Similarly, Le and Govindan (2024) emphasized that green innovation can strengthen corporate performance, particularly when organizational leaders demonstrate a strong concern for environmental outcomes. These studies suggest that environmental responsibility and business performance need not be treated as opposing objectives. Instead, they may be pursued through an integrated innovation strategy that aligns ecological priorities with organizational capabilities.

The potential value of innovation investment is also reflected in operational efficiency. Operational efficiency refers to an organization's capacity to use resources effectively, improve its processes, and manage costs without compromising the quality of its products or services. Environmental protection companies depend heavily on efficient resource utilization because their operations often involve specialized equipment, technical processes, environmental monitoring systems, and compliance-related expenditures. Investments in digital technologies, automation, energy-efficient systems, and process innovation may help these firms reduce waste, improve workflow coordination, and strengthen managerial decision-making.

Technology adoption is especially relevant to process optimization. Digital systems and automated technologies can improve data management, reduce repetitive tasks, accelerate operational procedures, and provide timely information for organizational decisions. Integrating Industry 4.0 technologies into green business strategies has been associated with improvements in organizational sustainability and performance (Alkaraan et al., 2024). Within environmental protection companies, such technologies may be applied to emissions monitoring, waste treatment, equipment maintenance, environmental data analysis, resource allocation, and service delivery. When appropriately implemented, technology adoption may therefore support both environmental objectives and operational effectiveness.

Innovation investment may also contribute to cost reduction. Although innovation requires initial expenditure, the resulting technologies and process improvements may reduce unnecessary resource consumption, operational delays, maintenance costs, and inefficiencies. Investments in research and technology may enable firms to identify more economical production methods, develop efficient environmental solutions, and improve the long-term use of organizational resources. Sun et al. (2025) demonstrated the importance of operational efficiency and environmental considerations in evaluating industrial performance, indicating that firms must consider both productivity and ecological consequences when assessing organizational effectiveness.

Beyond internal operational outcomes, innovation investment may also be associated with business growth. Business growth may be reflected in higher revenue turnover, an expanded market share, and a broader customer base. Firms that invest in research and development may introduce improved or differentiated products and services. Those that adopt advanced technologies may respond more rapidly to customer requirements and changes in the market. Green innovation initiatives may likewise enhance organizational reputation, strengthen stakeholder confidence, and create opportunities in markets increasingly oriented toward sustainable solutions.

For environmental protection companies, growth is closely connected to the ability to demonstrate technical competence, regulatory compliance, service reliability, and environmental credibility. Innovation can help firms distinguish themselves from competitors by providing more effective technologies and more sustainable service models. Innovation-driven development among environmental protection enterprises has also been associated with positive economic and environmental outcomes, including within public-private partnership projects (Feng et al., 2022). These outcomes suggest that innovation investment may contribute not only to internal efficiency but also to the market position and long-term viability of firms in the environmental sector.

China provides an important setting for examining these relationships. The country's continuing emphasis on green development, technological modernization, and environmental governance has created both opportunities and pressures for environmental protection companies. Firms in this sector are expected to support national sustainability objectives while operating in a competitive and technologically dynamic market. As environmental challenges become more complex,

companies must strengthen their research capabilities, adopt advanced technologies, and develop innovative solutions that improve environmental performance. However, these investments must also generate operational and commercial value if they are to remain sustainable over time.

Existing literature has examined the relationships between innovation, sustainability, operational efficiency, and firm performance. However, these relationships are often studied separately. Some studies focus on the contribution of technological or green innovation to environmental performance, while others emphasize operational productivity, financial performance, or market competitiveness. Comparatively limited attention has been given to the combined relationships among innovation investment, operational efficiency, and business growth within Chinese environmental protection companies. There is also a need for an integrated framework that identifies how research and development, technology adoption, and green innovation initiatives are associated with resource utilization, process optimization, cost reduction, revenue turnover, market share expansion, and customer base growth.

Addressing this gap is important because innovation investment cannot be evaluated solely according to the amount of resources allocated to research or technology. Its strategic value also depends on whether such investments improve organizational operations and contribute to sustainable growth. An integrated analysis can provide environmental protection companies with a clearer understanding of which innovation dimensions are most strongly associated with efficiency and growth outcomes. It can also support the formulation of managerial strategies that align innovation priorities with organizational performance.

Accordingly, this study aimed to examine the influence of innovation investment on the operational efficiency and business growth of environmental protection companies in China as the basis for an improved business performance framework. Specifically, it sought to:

1. determine innovation investment practices in terms of research and development, technology adoption, and green innovation initiatives;
2. assess operational efficiency with respect to resource utilization, process optimization, and cost reduction;
3. evaluate business growth in terms of revenue turnover, market share expansion, and customer base growth;
4. determine the significant relationships among innovation investment, operational efficiency, and business growth;
5. examine the statistical influence of research and development, technology adoption, and green innovation initiatives on operational efficiency and business growth; and
6. develop an improved business performance framework for environmental protection companies in China.

2. Review of Related Literature

2.1 Innovation Investment as a Strategic Organizational Capability

Innovation investment refers to the deliberate allocation of financial, technological, human, and organizational resources to activities that generate knowledge, improve technologies, refine processes, and create new or enhanced products and services. Its strategic significance has intensified as firms confront rapid technological change, stronger environmental regulation, heightened competition, and expanding stakeholder expectations concerning sustainability. Under these conditions, innovation investment is not simply an expenditure category; it is an organizational capability through which firms renew resources, respond to external change, and sustain long-term competitiveness.

Research and development remains one of the most established components of innovation investment because it expands the knowledge base from which firms develop technical solutions and improve existing products and processes. Qin et al. (2026) reported that R&D expenditure, capital investment, and green subsidies can strengthen green innovation efficiency, indicating that consistent research investment supports both technological advancement and environmentally oriented performance. For environmental protection companies, this capability is especially important because market opportunities and regulatory obligations frequently depend on the development of technically credible and ecologically responsive solutions.

Innovation investment also strengthens a firm's capacity to respond to sustainability-related pressures. Wu et al. (2025) found that ESG performance can promote corporate green innovation, while Yang et al. (2024) associated green technological innovation with improved ESG performance among manufacturing enterprises. Taken together, these findings suggest a reciprocal strategic relationship: sustainability expectations influence innovation priorities, and innovation capabilities can subsequently improve the firm's environmental and governance position.

The value created by innovation investment depends on whether firms can absorb, interpret, and apply new knowledge. Akhtar et al. (2024) emphasized the importance of green absorptive capacity and a supportive green innovation climate in converting innovation resources into environmental and organizational outcomes. Aslam et al. (2025) similarly linked green

innovation, technological connections, and knowledge management with sustainable performance among small and medium-sized enterprises. Innovation investment therefore involves more than acquiring equipment or funding research; it requires managerial routines, workforce competencies, and organizational learning mechanisms that translate resources into operational and competitive outcomes.

Comparable strategic analyses of established Philippine retailers show that legacy strengths create durable advantage only when firms reconfigure them through digital, sustainability, and diversification capabilities (Atento & Atento, 2025; Atento & Atento, 2026). A family-owned SME case likewise frames value innovation as a coordinated combination of digital transformation, sustainability, and customer-focused strategic renewal rather than as a stand-alone product initiative (Teodosio et al., 2025).

External institutions further shape the direction and effectiveness of innovation investment. Trevlopoulos et al. (2021) found that environmental regulation can encourage business innovation while improving intellectual capital, environmental performance, and economic performance. In environmental protection industries, regulatory requirements may therefore operate not only as constraints but also as signals that guide research priorities, technology choices, and differentiated capability development.

Viewed strategically, innovation investment becomes most valuable when it is aligned with the firm's environmental mandate, competitive position, knowledge base, and implementation capacity. This alignment allows research, technology, and green initiatives to function as mutually reinforcing capabilities rather than as fragmented projects. For environmental protection companies, the strategic question is consequently not whether to invest in innovation, but how to configure those investments so that they support organizational adaptation, environmental legitimacy, and sustained business performance.

2.2 Research and Development, Technology Adoption, and Green Innovation

Innovation investment may be operationalized through three related but distinct dimensions: research and development, technology adoption, and green innovation initiatives. R&D centers on the generation of knowledge and the development of new or improved technologies. Technology adoption concerns the acquisition, integration, and effective use of available digital systems, automation, equipment, and data tools. Green innovation incorporates environmental objectives into technologies, products, services, and processes. Their combined contribution depends on how well firms coordinate knowledge creation, implementation capability, and sustainability priorities.

R&D investment strengthens the capacity of organizations to develop new products, improve processes, and respond to technological and market change. Qin et al. (2026) indicated that research expenditure and related investments contribute to green innovation efficiency. Cobbinah et al. (2026) likewise associated innovation capacity with enterprise green total factor productivity, particularly when innovation is reinforced through digital transformation. These findings position R&D as a knowledge-generating foundation from which firms can improve productivity, environmental performance, and technological responsiveness.

The returns from R&D are rarely immediate. Environmental protection technologies may require specialized equipment, extended testing, regulatory approval, technical validation, and substantial capital before they can be commercialized or embedded in operations. Firms must therefore connect R&D priorities to identifiable environmental problems, customer requirements, operational bottlenecks, and longer-term strategic opportunities. Without this alignment, research activity may expand organizational knowledge without producing corresponding operational or market value.

Technology adoption complements R&D by allowing firms to incorporate digital systems, automation, modern equipment, and data-driven tools into existing operations. Sharma et al. (2026) linked digital transformation with improved financial and organizational performance, while Duong and Nguyen (2026) found that digitalization can enhance firm value and financial performance while supporting green initiatives. Alkaraan et al. (2024) further showed that Industry 4.0 technologies can reinforce green business strategies and sustainability-oriented organizational capabilities. These studies indicate that technology adoption can connect innovation inputs to more timely information, stronger coordination, and more efficient organizational processes.

Evidence from adjacent enterprise settings further suggests that digital value depends on the fit among technological features, organizational readiness, environmental pressures, and managerial intelligence (Carandang et al., 2026; Chen & Atento, 2026). Technology acquisition should therefore be evaluated as an organizational change process rather than as a purely technical purchase.

Employee capability is central to that change process. New systems may remain underused, improperly maintained, or weakly integrated when employees lack the skills and support needed to incorporate them into daily work. Evidence from vocational institutions preparing motor vehicle safety and technical inspectors similarly underscores the importance of effective, continuously improved training in sustaining specialized technical competence (Yu & Atento, 2026). Technology

investment should consequently be accompanied by workforce development, process redesign, implementation guidance, and performance monitoring.

Green innovation initiatives extend technological and organizational development toward explicit environmental objectives. These initiatives may include cleaner production systems, energy-efficient equipment, pollution-control technologies, waste-reduction methods, environmentally responsible product development, and sustainability-oriented process improvements. Mukhtar et al. (2025) associated green technology innovation and innovation capabilities with sustainability performance. Le and Govindan (2024) likewise demonstrated that green innovation can contribute to corporate performance, particularly when managerial concern for environmental outcomes is incorporated into organizational decisions.

Green innovation can also strengthen legitimacy and stakeholder confidence because firms are increasingly evaluated according to environmental credibility as well as technical and commercial performance. Feng et al. (2022) found that innovation-driven development among environmental protection enterprises involved in public-private partnership projects can generate both economic and environmental benefits. Research and development, technology adoption, and green innovation should therefore be treated as complementary mechanisms: R&D generates possibilities, technology adoption embeds useful systems, and green innovation directs these capabilities toward environmentally and commercially relevant outcomes.

2.3 Innovation Investment and Operational Efficiency

Operational efficiency refers to an organization's ability to achieve required outputs while using labor, capital, materials, energy, time, and information effectively. It is especially important for environmental protection companies because their operations frequently involve specialized technologies, technical personnel, compliance obligations, resource-intensive procedures, and substantial cost pressures. Within this setting, resource utilization, process optimization, and cost reduction represent related dimensions through which the operational consequences of innovation investment may be assessed.

Innovation investment can improve resource utilization by enabling firms to introduce efficient technologies and more precise monitoring systems. Digital platforms and automated tools may provide timely information on energy consumption, material use, equipment performance, waste generation, and production outputs. Abad-Segura et al. (2025) associated sustainable technologies with improved resource management, organizational competitiveness, and environmental conservation. The value of such technologies lies not only in reducing consumption but also in making resource flows more visible, measurable, and manageable.

Green innovation is particularly relevant to resource efficiency because it seeks to reduce the environmental burden created by organizational activities. Wang and Zhang (2025) showed that environmental regulation can shape the effectiveness of green investment among traditional energy enterprises. Khan et al. (2021) likewise found that proactive green innovation practices and reporting can support financial performance and sustainable development objectives. These findings suggest that environmental innovation can improve operational efficiency when it reduces waste, strengthens resource discipline, and aligns internal processes with sustainability requirements.

Process optimization involves the systematic redesign and improvement of workflows, procedures, coordination mechanisms, and production systems. Technology adoption may automate repetitive activities, improve data accuracy, shorten processing time, reduce operational delays, and support faster managerial decisions. Mehmood et al. (2025) linked big data analytics and green innovation with improved economic and environmental performance among manufacturing SMEs. Duong and Nguyen (2026) similarly showed that digitalization may strengthen organizational performance by improving operational capabilities and supporting green initiatives.

Comparable implementation studies show that operational gains from standards and improvement systems are conditioned by middle-manager engagement, resource adequacy, human factors, and organizational practices (Garcia & Atento, 2026; Gamasan & Atento, 2026). This reinforces the view that process technologies and formal systems require organizational ownership, sufficient resources, and coordinated implementation to produce reliable operational outcomes.

Organizational culture and governance determine whether innovation is translated into sustained operational improvement. Bhuiyan et al. (2025) emphasized that organizational commitment and an innovation-supportive culture can advance corporate environmental sustainability practices. Alkaraan et al. (2025) also connected servitization innovation and green supply chain management with sustainable performance under appropriate governance conditions. Technology alone is therefore insufficient; firms require accountability structures, cross-functional coordination, employee participation, and managerial follow-through.

Research on full-service dining likewise treats recurring service delay as a strategic liability, reinforcing the need to redesign process flows rather than normalize operational friction (Mendoza et al., 2026). For environmental protection

companies, similar latency may arise in technical approvals, monitoring, maintenance, documentation, procurement, or customer response, making process innovation essential to service reliability and organizational credibility.

Innovation may also support cost reduction by minimizing waste, improving equipment utilization, reducing errors, strengthening maintenance, and improving financial and operational monitoring. Although innovation investment can raise short-term expenditure, it may generate longer-term savings through energy efficiency, process reliability, preventive maintenance, and elimination of non-value-adding work. Overall, innovation contributes to operational efficiency when technological development, digital systems, environmental practices, employee capabilities, and governance arrangements are integrated around actual operational requirements rather than implemented as isolated initiatives.

2.4 Innovation, Operational Efficiency, and Business Growth

Business growth may be reflected in higher revenue turnover, an expanded market share, and a broader or more stable customer base. Innovation can contribute to these outcomes by enabling firms to develop differentiated offerings, improve service quality, increase responsiveness, and enter markets created by technological and environmental change. For environmental protection companies, growth also depends on the ability to demonstrate regulatory competence, technical reliability, and environmental credibility to customers, public agencies, and partner organizations.

Mora-Contreras and Carrillo-Hermosilla (2025) associated circular economy practices, eco-innovation, and Industry 4.0 with sustainability performance and competitive advantage. This relationship suggests that innovation strengthens market position when it allows firms to offer commercial value together with measurable environmental benefits. In environmental industries, such integration can distinguish firms whose services merely satisfy minimum requirements from those capable of providing more efficient, adaptable, and sustainable solutions.

Technology adoption may support revenue growth by improving productivity, expanding service capacity, and enabling access to new customer and geographic markets. Digital systems can strengthen communication, service responsiveness, project monitoring, and information available for market-related decisions. Duong and Nguyen (2026) related digitalization to firm value and financial performance, while Cobbinah et al. (2026) connected digital transformation and innovation capacity with productivity. Operational gains can contribute to revenue when firms convert improved capacity and information into better service, higher output, or more competitive solutions.

Green innovation may influence market share by differentiating firms and strengthening their reputation among environmentally conscious customers, regulators, and investors. Akhtar et al. (2024) indicated that a supportive green innovation climate can contribute to operational excellence and environmental performance. Yang et al. (2024) likewise associated green technological innovation with sustainability-oriented corporate development. For environmental protection companies, green capability can therefore function as both a technical qualification and a market signal.

In adjacent service and market-design settings, growth opportunities have been linked to converting customer-specific requirements and community-derived insights into differentiated value propositions (Benosa et al., 2026; Atento & Espelita, 2025). These examples illustrate that innovation becomes commercially consequential when firms translate information about users and stakeholders into concrete service attributes and strategic offerings.

Evidence from higher education marketing further indicates that brand trust and targeted social-media engagement can shape behavioral intent, illustrating how digital contact points translate organizational capabilities into prospective-customer response (Espelita et al., 2026). Environmental protection companies may similarly use digital channels to communicate technical competence, environmental benefits, service reliability, and demonstrated project outcomes to current and prospective clients.

Operational efficiency can reinforce the relationship between innovation and business growth. Effective resource utilization reduces avoidable losses and improves the capacity available for expansion. Process optimization strengthens responsiveness and service consistency, while sustainable cost reduction can support competitive pricing or release funds for reinvestment. Khan et al. (2021) connected green innovation practices with financial performance, and Mehmood et al. (2025) linked analytical and innovation capabilities with economic and environmental outcomes. Innovation-generated efficiency may therefore provide the internal capacity through which firms sustain revenue, market position, and customer relationships.

Innovation investment does not, however, automatically produce growth. Its effectiveness depends on strategic alignment, managerial competence, employee capability, operational execution, market responsiveness, and the ability to communicate and commercialize technological value. The relationships among innovation investment, operational efficiency, and business growth should consequently be examined as an integrated organizational process in which knowledge and technology must be converted into efficient operations and market-relevant outcomes.

2.5 Synthesis and Research Gap

The reviewed literature presents innovation investment as a multidimensional organizational strategy involving research and development, technology adoption, and green innovation. R&D expands knowledge and technological capability, technology adoption embeds digital and operational systems, and green innovation directs organizational development toward environmental responsibility (Qin et al., 2026; Mukhtar et al., 2025; Alkaraan et al., 2024). Their contribution depends on complementary managerial capabilities, employee competence, governance arrangements, and the alignment of innovation priorities with operational and market requirements.

The literature further indicates that innovation investment is associated with operational efficiency through improved resource utilization, process optimization, waste reduction, and cost management (Abad-Segura et al., 2025; Mehmood et al., 2025; Wang & Zhang, 2025). These operational improvements may strengthen revenue generation, market competitiveness, and customer development by increasing productivity, responsiveness, consistency, and service value. Green innovation may provide an additional source of differentiation because it combines commercial performance with environmental legitimacy (Akhtar et al., 2024; Le & Govindan, 2024).

Several gaps nevertheless remain. First, many studies examine innovation, environmental performance, operational efficiency, or financial performance separately rather than evaluating them within a unified organizational framework. Second, comparatively limited attention has been given to how research and development, technology adoption, and green innovation jointly relate to resource utilization, process optimization, cost reduction, revenue turnover, market share expansion, and customer-base growth. Third, much of the available evidence derives from manufacturing, energy, general corporate, or adjacent service contexts, while environmental protection companies have received less integrated empirical examination. Finally, context-specific evidence remains necessary because the organizational value of innovation may vary according to regulatory conditions, technological maturity, implementation capacity, and market structure.

The present study addresses these gaps by examining innovation investment as a multidimensional predictor of both operational efficiency and business growth among environmental protection companies in China. It also evaluates the relationships between operational efficiency and growth outcomes and uses the resulting evidence as the basis for an improved business performance framework. By integrating innovation inputs, operational outcomes, and growth indicators within one analysis, the study seeks to clarify how environmental protection companies may align technological development, sustainability, and organizational performance.

3. Methodology

3.1 Research Design

The study employed a quantitative descriptive-correlational research design to examine the relationships among innovation investment, operational efficiency, and business growth in environmental protection companies. The descriptive component was used to assess the respondents' perceptions of innovation investment practices, operational efficiency, and business growth. The correlational component determined the direction and strength of the relationships among the study variables, while multiple regression analysis was used to examine the statistical contribution of the dimensions of innovation investment to operational efficiency and business growth.

The design was appropriate because the study sought to describe existing organizational practices and determine whether research and development, technology adoption, and green innovation initiatives were significantly associated with and predictive of the identified organizational outcomes. Because the study used cross-sectional survey data, the results were interpreted as statistical relationships and predictive influences rather than definitive causal effects.

3.2 Participants and Study Setting

The participants were 400 officers from five environmental protection companies operating in Shandong Province, China. Eighty respondents were drawn from each participating company. The companies were engaged in environmental engineering, environmental protection equipment, environmental technology, and related business activities, with reported annual production values exceeding 10 million yuan.

Eligible respondents included managers, research and development personnel, sustainability officers, and other company officers with sufficient knowledge of their organizations' strategic, financial, and operational activities. Their organizational responsibilities enabled them to assess innovation investment practices, operational efficiency, and business growth within their respective companies.

3.3 Sampling Technique

The study used purposive or criterion-based sampling to identify respondents who possessed relevant knowledge of organizational innovation, operations, financial performance, and environmental initiatives. Respondents were included based on their roles and their access to information concerning the companies' research and development activities, technological investments, green innovation practices, operational processes, and business performance.

3.4 Research Instrument

Data were collected using a researcher-developed questionnaire based on the variables and dimensions presented in the study framework. The instrument consisted of 45 statements grouped into three major parts. The first part measured innovation investment through research and development, technology adoption, and green innovation initiatives. The second part measured operational efficiency through resource utilization, process optimization, and cost reduction. The third part measured business growth through revenue turnover, market share expansion, and customer base growth. Each dimension contained five items.

Responses were recorded using a four-point Likert scale: 4 for strongly agree, 3 for agree, 2 for disagree, and 1 for strongly disagree. The questionnaire underwent expert review in the fields of business management and environmental economics to establish content relevance and clarity. It was subsequently pilot-tested among 30 respondents. Internal consistency was assessed using Cronbach's alpha.

Table 1. *Internal Consistency of the Measurement Dimensions*

Construct	Dimension	Cronbach's alpha	Interpretation
Innovation investment	Research and development	.837	Good
	Technology adoption	.715	Acceptable
	Green innovation initiatives	.828	Good
Operational efficiency	Resource utilization	.828	Good
	Process optimization	.895	Good
	Cost reduction	.841	Good
Business growth	Revenue turnover	.878	Good
	Market share expansion	.834	Good
	Customer base growth	.793	Acceptable

Note. Alpha coefficients of .70 or higher were treated as acceptable. All nine dimensions met this criterion.

3.5 Data-Gathering Procedure

Permission to conduct the study was obtained from the participating environmental protection companies. Eligible officers were informed of the purpose of the research and invited to participate in the survey. Before the main data collection, the instrument underwent expert review, pilot testing, and reliability assessment. The study also secured approval from the university ethics committee before the survey was administered. Completed responses were checked, encoded, and prepared for statistical analysis.

3.6 Data Analysis

Weighted means, composite means, and ranks were used to describe the respondents' assessments of innovation investment practices, operational efficiency, and business growth.

The Kolmogorov-Smirnov test was used to assess the normality of the data distributions. The resulting probability values were below .05, indicating departures from normality. Consequently, Spearman's rank-order correlation coefficient was used to determine the relationships between innovation investment and operational efficiency, between innovation investment and business growth, and between operational efficiency and business growth. Multiple regression analysis was used to examine the statistical influence of research and development, technology adoption, and green innovation initiatives on operational efficiency and business growth. Statistical significance was evaluated at the .05 level.

3.7 Ethical Considerations

The study observed institutional research ethics requirements. Approval was obtained from the university ethics committee before data gathering, and permission was secured from the participating companies. Participation was voluntary, and respondents were informed of the purpose of the study before completing the questionnaire. No respondent names were collected. Individual responses were treated confidentially and used solely for research purposes. The study also sought to minimize potential risk and protect participant privacy, safety, and organizational information.

4. Results and Discussion

4.1 Innovation Investment Practices

Table 2 presents the consolidated assessment of innovation investment practices in terms of research and development, technology adoption, and green innovation initiatives. The overall composite mean of 3.14 indicates that respondents agreed that their companies practiced innovation investment across the three dimensions.

Table 2. *Innovation Investment Practices of Environmental Protection Companies*

Dimension	Composite mean	Highest-rated indicator	Mean	Lowest-rated indicator	Mean	Interpretation
Research and development	3.16	R&D activities improve company competitiveness	3.20	Consistent investment in new products or services through R&D	3.08	Agree
Technology adoption	3.15	Technology adoption improves operational efficiency	3.22	Employees are well trained in using adopted technologies	3.09	Agree
Green innovation initiatives	3.11	Green innovation contributes to company reputation	3.15	Sustainability considerations guide innovation decisions	3.07	Agree
Overall	3.14					Agree

Note. 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree.

Research and development obtained the highest composite mean of 3.16. Respondents particularly recognized the contribution of R&D activities to organizational competitiveness. This finding indicates that research activities were perceived not merely as technical or compliance-oriented functions but as mechanisms for strengthening the firms' competitive positions. R&D can enable environmental protection companies to improve existing technologies, develop new services, and respond to changing environmental and market requirements.

However, the comparatively lower assessment of consistent investment in new products and services suggests that recognizing the strategic value of R&D does not always translate into continuous commercialization or product-development activity. Environmental technologies may require substantial capital, specialized expertise, testing, and regulatory compliance before they produce commercially usable outputs.

Technology adoption recorded a composite mean of 3.15. The highest-rated item indicated that technological adoption improved operational efficiency, supporting the view that digital systems, automation, and equipment modernization can strengthen workflows and productivity. Digital transformation has been associated with enhanced organizational and financial performance because it allows firms to improve information processing, coordination, and resource management (Sharma et al., 2026; Duong & Nguyen, 2026).

The lowest-rated technology-adoption item concerned employee training. Although the item remained within the "Agree" range, its relative position suggests that workforce capability may not be developing at the same pace as technological acquisition. New systems cannot produce their full organizational value unless employees understand how to operate, maintain, interpret, and integrate them into routine processes.

Green innovation initiatives obtained the lowest of the three composite means at 3.11, although respondents still agreed that such initiatives were practiced. The strongest item concerned organizational reputation, indicating that firms viewed green innovation as a source of credibility among customers, regulators, and other stakeholders. The lowest-rated item indicated that sustainability considerations did not always serve as the primary guide for innovation-related decisions. This suggests a potential gap between the reputational benefits of green innovation and its integration into strategic decision-making. Le and

Govindan (2024) emphasized that the organizational benefits of green innovation are strengthened when managerial environmental concern is integrated into corporate decisions.

4.2 Operational Efficiency

Table 3 presents the assessment of operational efficiency in terms of resource utilization, process optimization, and cost reduction. The overall composite mean of 3.11 indicates that respondents agreed that their organizations demonstrated operational efficiency across the three dimensions.

Table 3. *Operational Efficiency of Environmental Protection Companies*

Dimension	Composite mean	Highest-rated indicator	Mean	Lowest-rated indicator	Mean	Interpretation
Resource utilization	3.13	Company maximizes the use of available resources	3.16	Systems minimize resource wastage	3.08	Agree
Process optimization	3.10	Technology adoption improves process efficiency	3.16	Automation reduces repetitive tasks	3.02	Agree
Cost reduction	3.10	Innovation minimizes unnecessary expenses	3.16	Cost-reduction measures are sustainable and long-term focused	3.06	Agree
Overall	3.11					Agree

Note. 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree.

Resource utilization received the highest composite mean of 3.13. Respondents agreed that their companies maximized available resources and used energy-efficient systems and practices. Effective resource utilization is central to environmental protection companies because their organizational legitimacy depends partly on whether their own operations demonstrate responsible use of energy, materials, and natural resources.

Nevertheless, the lowest-rated item concerned the existence of formal systems for minimizing resource wastage. The result suggests that firms may practice resource conservation operationally without having equally developed measurement, monitoring, or waste-control systems. Informal efficiency practices can produce short-term benefits, but formal systems are needed to establish baselines, monitor trends, assign responsibility, and identify recurring sources of waste. Sustainable technologies and systematic resource management have been associated with stronger environmental and organizational performance (Abad-Segura et al., 2025).

Process optimization and cost reduction both recorded composite means of 3.10. In process optimization, technology adoption was again the highest-rated indicator. This reinforces the earlier finding that technological investment was viewed primarily as a means of improving internal efficiency. Digital tools and automated systems may allow firms to simplify workflows, improve information accuracy, reduce operational delays, and strengthen coordination among departments.

The lowest-rated process-optimization indicator concerned the reduction of repetitive work through automation. This suggests that automation may have been introduced only partially or unevenly across organizational functions. Firms may possess modern equipment or digital platforms while continuing to rely on manual procedures in administrative, technical, or monitoring activities. Mehmood et al. (2025) associated analytical and technological capabilities with improved economic and environmental performance, but such benefits depend on the depth of system integration.

For cost reduction, respondents most strongly agreed that innovation initiatives helped minimize unnecessary expenses. Innovation may reduce costs by improving energy efficiency, limiting material waste, reducing process errors, and improving equipment use. The lowest-rated item concerned whether cost-reduction strategies were sustainable and long-term oriented. Sustainable cost reduction should emerge from process redesign, resource efficiency, technology integration, and preventive maintenance rather than from reductions that compromise service quality.

4.3 Business Growth

Table 4 presents the respondents' evaluation of business growth in terms of revenue turnover, market share expansion, and customer base growth. The overall composite mean of 3.12 indicates agreement that the companies experienced favorable growth-related outcomes.

Table 4. *Business Growth of Environmental Protection Companies*

Dimension	Composite mean	Highest-rated indicator	Mean	Lowest-rated indicator	Mean	Interpretation
Revenue turnover	3.12	Company diversifies products or services to increase revenue	3.17	Green innovation opens new revenue opportunities	3.10	Agree
Market share expansion	3.12	Company has gained a competitive advantage in the industry	3.14	Market share has increased because of innovative offerings	3.10	Agree
Customer base growth	3.11	Innovation allows the company to retain existing customers	3.14	Green initiatives increase customer loyalty	3.07	Agree
Overall	3.12					Agree

Note. 3.50-4.00 = Strongly Agree; 2.50-3.49 = Agree; 1.50-2.49 = Disagree; 1.00-1.49 = Strongly Disagree.

Revenue turnover and market share expansion obtained equal composite means of 3.12, while customer base growth recorded a closely comparable mean of 3.11. The narrow differences indicate that respondents perceived business growth as broadly distributed across financial, competitive, and customer-related outcomes rather than concentrated in a single dimension.

Product and service diversification was the highest-rated revenue-related indicator. Environmental protection companies may use diversification to serve new industries, respond to emerging environmental requirements, and reduce dependence on a limited number of services or clients. Innovation supports diversification when it enables firms to convert technical knowledge into marketable technologies, engineering services, environmental solutions, or monitoring systems.

Green innovation opening new revenue opportunities was the lowest-rated item within revenue turnover. Although still favorably assessed, the result suggests that green technologies may be contributing more clearly to reputation and compliance than to identifiable new income streams. The commercialization of green innovation may require market development, customer education, financing support, and clearer articulation of the economic value of environmentally superior technologies.

For market share expansion, respondents most strongly agreed that their companies had gained a competitive advantage. However, they gave a slightly lower assessment to the direct increase in market share attributable to innovative offerings. Innovation may strengthen perceived capability, differentiation, and responsiveness before it produces measurable changes in market share.

Customer retention was the strongest indicator of customer base growth. This suggests that innovation may have been more effective in strengthening relationships with existing customers than in rapidly acquiring new ones. Green initiatives increasing customer loyalty received the lowest mean in this section. Environmental responsibility alone may be insufficient to create loyalty unless it is accompanied by clear technical performance, service quality, economic value, and effective communication.

4.4 Relationships Among Innovation Investment, Operational Efficiency, and Business Growth

4.4.1 Innovation Investment and Operational Efficiency

Table 5 shows the relationships between the dimensions of innovation investment and operational efficiency. All coefficients were positive and statistically significant at $p < .001$.

Table 5. *Relationships Between Innovation Investment and Operational Efficiency*

Innovation investment dimension	Resource utilization, ρ	Process optimization, ρ	Cost reduction, ρ
Research and development	.774***	.720***	.602***
Technology adoption	.781***	.774***	.621***
Green innovation initiatives	.798***	.789***	.619***

Note. ***p < .001.

The correlations ranged from .602 to .798, indicating substantial positive relationships. Green innovation initiatives had the strongest relationships with resource utilization (ρ = .798) and process optimization (ρ = .789). These results suggest that firms reporting stronger green innovation practices also tended to report more effective use of resources and more highly optimized processes.

Technology adoption had the strongest relationship with cost reduction (ρ = .621), although this coefficient was only marginally higher than that of green innovation initiatives (ρ = .619). Digitalization, automation, equipment modernization, and information systems may contribute to cost efficiency by reducing errors, improving monitoring, and simplifying operational activities.

Research and development was positively related to all three operational dimensions, with the strongest association observed for resource utilization. R&D may enable firms to develop processes and technologies that use materials, energy, and equipment more efficiently. The comparatively lower relationship with cost reduction indicates that the financial benefits of R&D may take longer to materialize or may depend on successful implementation and commercialization.

4.4.2 Innovation Investment and Business Growth

Table 6 presents the relationships between innovation investment and business growth. All relationships were positive and statistically significant at $p < .001$.

Table 6. *Relationships Between Innovation Investment and Business Growth*

Innovation investment dimension	Revenue turnover, ρ	Market share expansion, ρ	Customer base growth, ρ
Research and development	.709***	.699***	.716***
Technology adoption	.754***	.746***	.735***
Green innovation initiatives	.741***	.770***	.721***

Note. ***p < .001.

The coefficients ranged from .699 to .770. Technology adoption showed the strongest relationship with revenue turnover (ρ = .754), suggesting that companies with stronger technological capabilities also tended to report stronger revenue outcomes. Technology may improve revenue through productivity gains, improved service delivery, increased operational capacity, and faster response to customers.

Green innovation initiatives demonstrated the strongest relationship with market share expansion (ρ = .770). This finding indicates that environmentally oriented innovation may help firms distinguish themselves in markets where regulatory compliance, sustainability, and technical credibility are important competitive criteria.

Research and development had its strongest relationship with customer base growth (ρ = .716). R&D may contribute to customer development by enabling companies to improve products, customize services, and address specialized environmental problems. The correlations indicate that the variables moved together within the sampled organizations but do not establish that innovation alone caused the reported growth outcomes.

4.4.3 Operational Efficiency and Business Growth

Table 7 presents the relationships between operational efficiency and business growth. All relationships were positive and statistically significant at $p < .001$.

Table 7. *Relationships Between Operational Efficiency and Business Growth*

Operational efficiency dimension	Revenue turnover, ρ	Market share expansion, ρ	Customer base growth, ρ
Resource utilization	.799***	.778***	.746***
Process optimization	.765***	.766***	.702***
Cost reduction	.729***	.724***	.687***

Note. ***p < .001.

Resource utilization had the strongest relationship with revenue turnover (ρ = .799), which was also the highest correlation reported across the three relationship tables. This indicates that companies reporting more effective use of

resources also tended to report stronger revenue performance. Efficient resource utilization can improve productivity and release resources for service expansion, technological development, and market activities.

Process optimization was strongly associated with market share expansion (ρ = .766) and revenue turnover (ρ = .765). Efficient workflows may help companies deliver projects more consistently, reduce delays, and respond more effectively to market requirements. These operational capabilities can strengthen customer confidence and competitive positioning.

Cost reduction was positively related to all business-growth dimensions, although its correlations were lower than those of resource utilization and process optimization. This pattern indicates that business growth may depend more strongly on productive use of resources and efficient processes than on cost minimization alone.

4.5 Predictive Influence of Innovation Investment

4.5.1 Operational Efficiency

Table 8 presents the multiple regression coefficients for operational efficiency. Research and development, technology adoption, and green innovation initiatives were all statistically significant predictors.

Table 8. *Regression Coefficients Predicting Operational Efficiency*

Predictor	B	SE	β	t	p
Constant	.501	.068	—	7.349	< .001
Research and development	.186	.045	.210	4.139	< .001
Technology adoption	.235	.057	.267	4.096	< .001
Green innovation initiatives	.411	.043	.460	9.666	< .001

The standardized coefficients indicate that green innovation initiatives were the strongest predictor of operational efficiency (β = .460), followed by technology adoption (β = .267) and research and development (β = .210). Holding the other predictors constant, higher scores in each innovation dimension were associated with higher operational-efficiency scores.

The result emphasizes the operational importance of environmental innovation within companies whose principal activities are already connected to environmental protection. Green innovation may influence efficiency by encouraging energy conservation, waste reduction, cleaner processes, regulatory alignment, and more systematic environmental monitoring.

Technology adoption also made a meaningful contribution, reinforcing the descriptive and correlational findings. Digital and automated systems may improve operational visibility, coordination, and process control. R&D had the smallest standardized coefficient of the three but remained statistically significant, indicating that research activities contributed independently to operational efficiency after accounting for technology adoption and green innovation.

The source statistical output did not report the model's R^2, adjusted R^2, F statistic, confidence intervals, or multicollinearity diagnostics. These values were therefore not inferred or added. Their absence limits assessment of the model's total explanatory power and diagnostic adequacy.

4.5.2 Business Growth

Table 9 presents the multiple regression coefficients for business growth. All three innovation-investment dimensions were statistically significant predictors.

Table 9. *Regression Coefficients Predicting Business Growth*

Predictor	B	SE	β	t	p
Constant	.386	.087	—	4.459	< .001
Research and development	.190	.057	.196	3.325	.001
Technology adoption	.312	.073	.322	4.271	< .001
Green innovation initiatives	.368	.054	.375	6.796	< .001

Green innovation initiatives were again the strongest predictor (β = .375), followed by technology adoption (β = .322) and research and development (β = .196). These results indicate that each innovation dimension contributed independently to business growth when the other dimensions were held constant.

Green innovation may contribute to growth by strengthening reputation, facilitating regulatory compliance, differentiating services, and creating access to environmentally oriented market opportunities. Technology adoption may support growth through improved productivity, faster service delivery, better customer communication, and greater responsiveness to market demands. R&D may contribute by developing new or improved environmental technologies and services, although its commercial effects may require a longer time horizon.

As with the operational-efficiency model, the source output did not include R^2, adjusted R^2, the overall F test, confidence intervals, or regression diagnostics. The findings therefore support the statistical significance and relative contribution of the predictors but do not permit a complete assessment of model fit.

4.5.3 Improved Business Performance Framework

Based on the findings, the improved business performance framework positions innovation investment as the central strategic input. Research and development, technology adoption, and green innovation initiatives are linked to operational efficiency and business growth. Operational efficiency is represented by resource utilization, process optimization, and cost reduction, while business growth is reflected in revenue turnover, market share expansion, and customer base growth.

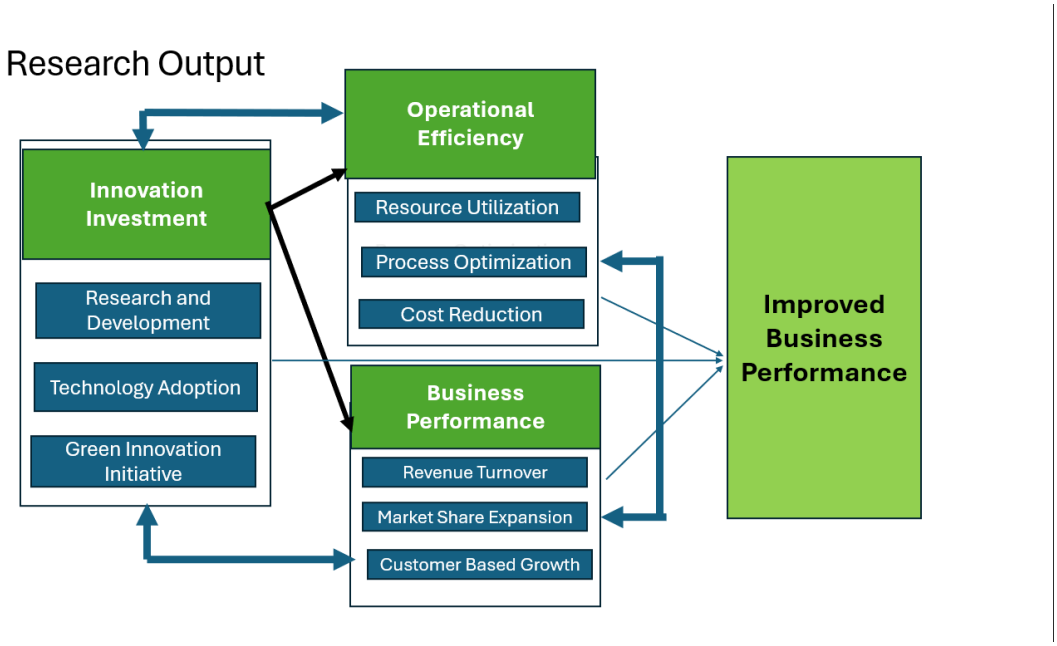

Figure 1. *Improved Business Performance Framework for Environmental Protection Companies*

The significant relationship between operational efficiency and business growth indicates that efficiency should also be treated as an important organizational pathway through which innovation-related capabilities may support performance. However, the study did not conduct a formal mediation analysis. Operational efficiency should therefore not be described as an empirically confirmed mediator. Instead, it represents a theoretically and statistically related mechanism within the proposed framework.

4.6 Discussion

The findings demonstrate that innovation investment, operational efficiency, and business growth were all positively assessed by respondents from the five environmental protection companies. The similar composite means suggest that the organizations had developed favorable but not fully institutionalized innovation and performance practices. None of the major dimensions reached the "Strongly Agree" category, indicating that substantial room for organizational development remained.

Research and development emerged as the most highly rated innovation-investment dimension, while green innovation initiatives recorded the lowest composite mean. This pattern suggests that firms may have more established experience with conventional R&D and technology-related investments than with the complete integration of environmental sustainability into strategic innovation decisions. Green innovation was nevertheless the strongest predictor of both operational efficiency and business growth. The least highly rated innovation dimension therefore produced the strongest relative predictive contribution.

The result implies that green innovation may represent an underdeveloped but strategically powerful capability. Investments in environmentally friendly technologies, cleaner processes, sustainability-oriented decision systems, and

innovative regulatory-compliance approaches may yield benefits extending beyond environmental performance. They may also improve internal efficiency, market differentiation, and organizational reputation. This interpretation is consistent with studies linking green technological innovation with sustainability and corporate performance (Mukhtar et al., 2025; Yang et al., 2024; Le & Govindan, 2024).

Technology adoption also played a prominent role throughout the findings. Respondents identified technology as an important contributor to operational efficiency, process improvement, cost control, revenue turnover, and market responsiveness. Its standardized effects were second only to green innovation in both regression models. These findings support the strategic integration of digitalization, automation, advanced equipment, data systems, and workforce capability development. Industry 4.0 and digital transformation can reinforce green business strategies when technological adoption is aligned with governance and organizational capability (Alkaraan et al., 2024).

At the same time, the comparatively lower assessment of employee training and the limited reduction of repetitive work indicate that some technology investments may not yet be fully embedded in daily operations. Firms may acquire technologies faster than they develop the employee competencies and redesigned processes needed to use them effectively. The result supports a socio-technical approach in which technological investment is accompanied by training, process redesign, role clarification, and performance monitoring.

Operational efficiency was strongly related to business growth, particularly through resource utilization and process optimization. Resource utilization showed the highest correlation with revenue turnover, suggesting that growth in environmental protection companies depends not only on market expansion but also on the productive use of existing organizational assets. Companies that manage materials, energy, equipment, technical expertise, and working time effectively may be better positioned to improve financial performance.

Process optimization was likewise strongly associated with revenue and market share. Environmental protection projects often require technical coordination, regulatory documentation, engineering work, equipment installation, monitoring, and after-sales service. Delays or inconsistencies in these processes can weaken customer trust and competitive performance. Continuous workflow improvement can therefore contribute directly to market reliability and organizational growth.

Cost reduction had significant but comparatively weaker relationships with business-growth outcomes. This finding indicates that growth should not be pursued primarily through aggressive expenditure reduction. Resource productivity and process capability may contribute more strongly to growth than cost minimization by itself. For environmental protection companies, long-term performance requires a balance between efficiency, technical quality, innovation capacity, and compliance.

The business-growth findings also reveal that innovation appeared more effective in supporting customer retention and competitive positioning than in producing clearly differentiated effects from green initiatives alone. Customers may value innovation when it improves reliability, responsiveness, technical quality, and service outcomes. Environmental benefits may strengthen customer relationships when companies explain their practical and economic significance rather than presenting them only as abstract sustainability commitments.

Overall, the findings support an integrated business performance framework in which innovation investment strengthens organizational capabilities associated with efficiency and growth. Research and development generates knowledge and technological options. Technology adoption enables firms to modernize and improve operational systems. Green innovation aligns technological and organizational development with environmental responsibility. Together, these capabilities are associated with improved resource utilization, optimized processes, cost control, revenue development, market expansion, and customer growth.

The results must be interpreted within the limitations of a cross-sectional, self-reported survey. The findings establish significant associations and predictive relationships within the sampled companies but do not demonstrate definitive causality. The study also relied on officers' perceptions rather than independently audited financial, operational, or environmental records. Future testing of the framework may therefore incorporate longitudinal data, objective performance measures, mediation analysis, and broader samples of environmental protection companies.

5. Conclusions, Recommendations, and Implications

5.1 Conclusions

1. The participating environmental protection companies generally practiced innovation investment through research and development, technology adoption, and green innovation initiatives. Research and development received the highest

overall assessment, while sustainability considerations appeared to be less consistently integrated into innovation-related decision-making.

2. The companies generally demonstrated favorable operational efficiency in terms of resource utilization, process optimization, and cost reduction. Resource utilization received the highest assessment, although opportunities remained to strengthen formal waste-minimization systems, expand automation, and develop more sustainable long-term cost-reduction strategies.
3. Respondents generally perceived favorable business growth in terms of revenue turnover, market share expansion, and customer base growth. Product and service diversification, competitive advantage, and customer retention emerged as relatively strong practices. The commercial value of green innovation, however, may not yet be fully developed or effectively communicated to the market.
4. Innovation investment was positively and significantly related to operational efficiency. Green innovation initiatives demonstrated the strongest relationships with resource utilization and process optimization, while technology adoption showed the strongest relationship with cost reduction.
5. Innovation investment was positively and significantly related to business growth. Technology adoption demonstrated the strongest relationship with revenue turnover, green innovation initiatives showed the strongest relationship with market share expansion, and research and development was strongly associated with customer base growth.
6. Operational efficiency was positively and significantly related to business growth. Resource utilization had the strongest relationship with revenue turnover, while process optimization was strongly associated with market share expansion. Cost reduction was also significantly related to all business-growth dimensions, although its relationships were comparatively weaker.
7. Research and development, technology adoption, and green innovation initiatives significantly predicted operational efficiency and business growth. Green innovation initiatives emerged as the strongest predictor in both regression models, followed by technology adoption and research and development.
8. The findings support the Improved Business Performance Framework, which positions innovation investment as a central strategic input associated with operational efficiency and business growth. Because formal mediation analysis was not conducted, operational efficiency should be viewed as a related organizational mechanism rather than an empirically confirmed mediator.

5.2 Recommendations

1. Environmental protection companies should strengthen the integration of sustainability into innovation-related decision-making by incorporating environmental objectives into investment screening, strategic planning, project evaluation, budgeting, technology selection, and performance assessment.
2. Companies should sustain investment in research and development while improving the conversion of R&D outputs into commercially viable products, services, and operational solutions. R&D programs should be aligned with customer requirements, regulatory developments, emerging environmental problems, and long-term organizational priorities.
3. Technology adoption should be accompanied by systematic employee training, workflow redesign, and implementation support. Training programs should be integrated with technology acquisition so that investments in automation, digitalization, and advanced equipment generate measurable operational benefits.
4. The participating companies should expand automation in processes that remain repetitive, time-consuming, or prone to human error, including environmental monitoring, reporting, inventory management, equipment maintenance, project documentation, financial tracking, and customer-service processes.
5. Formal systems for resource and waste management should be strengthened through indicators for energy consumption, material use, equipment utilization, process loss, waste generation, and environmental performance.
6. Cost-reduction strategies should be designed for long-term sustainability rather than short-term expenditure minimization. Companies should prioritize preventive maintenance, process improvement, energy efficiency, waste reduction, equipment optimization, and digital monitoring.
7. Environmental protection companies should improve the market communication of their green innovation initiatives by translating environmental benefits into concrete customer value, including lower operating costs, reduced regulatory risk, improved energy efficiency, better environmental compliance, and stronger organizational reputation.
8. Companies may use the Improved Business Performance Framework as a strategic planning and performance-monitoring guide, with measurable indicators, assigned responsibilities, implementation timelines, and periodic performance reviews.

9. Managers should avoid treating innovation investment, operational efficiency, and business growth as separate functions. Cross-functional coordination should be strengthened among research and development, operations, finance, sustainability, information technology, marketing, and senior management.
10. Future researchers should test the framework in other regions, industries, and organizational settings using larger and more diverse samples, objective financial and operational indicators, environmental-performance records, longitudinal data, formal mediation analysis, or structural equation modeling.

5.3 Implications of the Study

Managerial Implications

The findings indicate that managers should evaluate innovation investment according to its contribution to both operational capability and business growth. Innovation should not be assessed solely through research expenditure, technology acquisition, or the number of green projects implemented. Its value should also be measured through improvements in resource productivity, workflow efficiency, cost management, revenue generation, competitive position, and customer development.

The strong predictive contribution of green innovation suggests that sustainability-oriented investments can serve as a source of operational and competitive advantage. Managers should therefore integrate environmental performance into mainstream business strategy rather than assigning it exclusively to compliance or sustainability units.

Practical Implications

Environmental protection companies may obtain greater value from technology investment when technological acquisition is combined with workforce development and process redesign. The lower assessment of employee training and automation indicates that practical implementation remains a critical concern. Technology investments should include training plans, operating standards, maintenance arrangements, user support, and performance indicators.

The findings also suggest that customer-facing strategies are needed to commercialize environmental innovation. Firms must demonstrate how green technologies and practices improve customer operations, reduce costs, lower environmental risks, and support regulatory compliance.

Theoretical Implications

The study supports an integrated perspective in which innovation investment, operational efficiency, and business growth are interrelated organizational domains. Research and development, technology adoption, and green innovation initiatives operate as complementary innovation capabilities, while resource utilization, process optimization, and cost reduction represent important operational outcomes.

The results further indicate that green innovation may generate both environmental and business value. This supports the view that sustainability-oriented innovation is not merely a response to external regulation but may also strengthen internal efficiency and market competitiveness.

Methodological Implications

The study demonstrates the usefulness of examining innovation investment as a multidimensional construct rather than as a single aggregate variable. Separating research and development, technology adoption, and green innovation initiatives made it possible to identify their distinct relationships and predictive contributions.

However, the cross-sectional and self-reported nature of the study limits causal interpretation. Future research should combine perceptual survey data with audited financial, operational, technological, and environmental indicators. Longitudinal designs may also provide stronger evidence regarding the sequence through which innovation investment influences efficiency and growth.

Institutional and Policy Implications

Industry associations and public agencies may support environmental protection companies through innovation incentives, green financing mechanisms, technology-development programs, workforce training, and partnerships among firms, universities, and research institutions. Policies encouraging green technology development should consider not only environmental outcomes but also the operational and commercial capabilities required for successful implementation.

Support programs may be particularly valuable for firms facing financial or technical constraints in sustaining R&D, adopting advanced technologies, or commercializing green innovations. Coordinated institutional support can help strengthen the competitiveness and sustainability of the environmental protection industry.

6. References

Abad-Segura, E., Castillo-Díaz, F. J., Batlles-delaFuente, A., & Belmonte-Ureña, L. J. (2025). The impact of sustainable technologies on business strategy and competitiveness. In S. S. Muthu (Ed.), Assessment of social sustainability management in various sectors (pp. 103-130). Springer. https://doi.org/10.1007/978-3-031-81029-9_6

Akhtar, S., Li, C., Sohu, J. M., Rasool, Y., Hassan, M. I. U., & Bilal, M. (2024). Unlocking green innovation and environmental performance: The mediated moderation of green absorptive capacity and green innovation climate. Environmental Science and Pollution Research, 31, 4547-4562. https://doi.org/10.1007/s11356-023-31403-w

Alkaraan, F., Elmarzouky, M., Hussainey, K., Venkatesh, V. G., Shi, Y., & Gulko, N. (2024). Reinforcing green business strategies with Industry 4.0 and governance towards sustainability: Natural-resource-based view and dynamic capability. Business Strategy and the Environment, 33(4), 3588-3606. https://doi.org/10.1002/bse.3665

Alkaraan, F., Elmarzouky, M., Jabbour, A. B. L. de S., Jabbour, C. J. C., & Gulko, N. (2025). Maximising sustainable performance: Integrating servitisation innovation into green sustainable supply chain management under the influence of governance and Industry 4.0. Journal of Business Research, 186, 115029. https://doi.org/10.1016/j.jbusres.2024.115029

Aslam, M., Ahmad, B., & Rasheed, T. (2025). Navigating the impact of green innovation, technological linkages, and knowledge management on sustainable performance of SMEs. Journal of International Entrepreneurship, 23(3), 593-618. https://doi.org/10.1007/s10843-024-00371-8

Atento, A. G. B., & Atento, R. G. O. (2026). Legacy retail under digital disruption: Strategic insights from National Book Store's omnichannel transition in the Philippines. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/nny9z718

Atento, A. G., & Atento, R. G. (2025). A case study of Mercury Drug Corporation: Strategic adaptation to universal healthcare and digital disruption in the Philippines. International Journal of Health & Business Analytics, 1(1). https://doi.org/10.65166/zhw7dd39

Atento, R. G., & Espelita, C. A. M. H. (2025). From community voice to marketing strategy: The feeder-school ecosystem as basis for a consumer-centered marketing framework. International Journal of Health and Business Analytics, 1(2). https://doi.org/10.65166/mt4em434

Benosa, I. R., Atento, R. G. O., Martinez, V. C., Mendoza, J. M., Mesias, R. G., & Rivera, G. C. M. (2026). Value innovation through pre-arrival room customization: A Blue Ocean Strategy design for app-enabled hospitality personalization. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/0h7xt639

Bhuiyan, F., Adu, D. A., Ullah, H., & Islam, N. (2025). Employee organisational commitment and corporate environmental sustainability practices: Mediating role of organisation innovation culture. Business Strategy and the Environment, 34(4), 4485-4506. https://doi.org/10.1002/bse.4200

Carandang, D., Baran, B., Espelita, C. A. M. H., Atento, A. G. B., & Atento, R. G. O. (2026). Perceptions of accounting software among SMEs in Calamba City, Philippines: A Technology-Organization-Environment (TOE) framework. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/dxqbny15

Chen, S., & Atento, R. G. (2026). Big data as a strategic asset: Competitive advantage, business model transformation, and managerial intelligence in Chinese enterprises. Journal of Enterprise Strategy and Management Innovation, 1(2).

Cobbinah, J., Osei, A., & Amoah, J. O. (2026). Innovating for a greener future: Do digital transformation and innovation capacity drive enterprise green total factor productivity in the knowledge economy? Journal of the Knowledge Economy, 17(1), 325-363. https://doi.org/10.1007/s13132-025-02673-1

Duong, H. K., & Nguyen, H. C. (2026). The impact of digitalisation on firm value, financial performance, and green initiatives: Evidence from Vietnam, an emerging economy. Journal of Applied Accounting Research, 27(1), 110-140. https://doi.org/10.1108/JAAR-01-2025-0015

Espelita, C. A. M. H., Atento, A. G. B., & Atento, R. G. O. (2026). Social media marketing and enrollment intent among college-bound learners: Evidence from a private higher education institution in Region IV-A, Philippines. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/bcn4pt87

Feng, J., Wang, N., & Sun, G. (2022). Measurement of innovation-driven development performance of large-scale environmental protection enterprises investing in public-private partnership projects based on the hybrid method. Sustainability, 14(9), 5096. https://doi.org/10.3390/su14095096

Gamasan, R., & Atento, R. G. O. (2026). Localized quality management system implementation and operational performance in a Philippine maritime manning office: The roles of human factors and organizational practices. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/m4htka42

Garcia, A. E., & Atento, R. G. O. (2026). Engagement and perceptions of middle managers in PhilHealth Benchbook II accreditation: Evidence from a tertiary hospital case study. Journal of Enterprise Strategy & Management Innovation, 1(1). https://doi.org/10.65166/jev58v44

Khan, P. A., Johl, S. K., & Akhtar, S. (2021). Firm sustainable development goals and firm financial performance through the lens of green innovation practices and reporting: A proactive approach. Journal of Risk and Financial Management, 14(12), 605. https://doi.org/10.3390/jrfm14120605

Le, T. T., & Govindan, K. (2024). Boosting green innovation on corporate performance: Managerial environmental concern's moderating role. Business Strategy and the Environment, 33(7), 6254-6274. https://doi.org/10.1002/bse.3795

Mehmood, K., Jabeen, F., Rashid, M., Alshibani, S. M., Lanteri, A., & Santoro, G. (2025). Unraveling the transformation: The three-wave time-lagged study on big data analytics, green innovation and their impact on economic and environmental performance in manufacturing SMEs. European Journal of Innovation Management, 28(6), 2189-2216. https://doi.org/10.1108/EJIM-10-2023-0903

Mendoza, E., Magnaye, R., Mendoza, F., Atento, R. G., Atento, A. G., Quinto, L., ... & Espelita, C. A. M. (2026). Operational latency as a strategic liability: Service delivery failures, customer attrition, and the case for process innovation in full-service dining establishments. Journal of Enterprise Strategy and Management Innovation (JESMI), 1(2). https://doi.org/10.65166/as485767

Mora-Contreras, R., & Carrillo-Hermosilla, J. (2025). Revealing the effects of circular economy, eco-innovation and Industry 4.0 on sustainability performance and competitive advantage in manufacturing companies. Sustainable Development, 33(S1), 1249-1270. https://doi.org/10.1002/sd.70075

Mukhtar, B., Shad, M. K., & Lai, F. W. (2025). Fostering sustainability performance in the Malaysian manufacturing companies: The role of green technology innovation and innovation capabilities. Benchmarking: An International Journal, 32(3), 992-1016. https://doi.org/10.1108/BIJ-07-2023-0468

Qin, Z., Ali, Z., Ali, A., & Abdul, Q. (2026). The impact of R&D expenditure, capital investment, and green subsidies on green innovation efficiency: Evidence from Pakistani manufacturing enterprises. Environment, Development and Sustainability. Advance online publication. https://doi.org/10.1007/s10668-025-07254-5

Sharma, M., Singh, B., & Kumar, S. (2026). Impact of digital transformation on financial performance: A case study on India's listed companies from 2012 to 2024. Digital Policy, Regulation and Governance, 28(4), 392-410. https://doi.org/10.1108/DPRG-04-2025-0085

Sun, J., Rosli, A. B., Daud, A., & Yan, X. (2025). Evaluation of operational efficiency in China's pharmaceutical industry and analysis of environmental impacts. Economies, 13(4), 90. https://doi.org/10.3390/economies13040090

Teodosio, G. M., Atento, R. G., Boa, R. A., Malijan, A., Malolos, Q. A., Merciales, P. A., & Ricablanca, P. J. (2025). Creating a Blue Ocean for family-owned SMEs: Value innovation, digital transformation, and sustainability in the case of Ivan Color Paint Center. International Journal of Health & Business Analytics, 1(2). https://doi.org/10.65166/x4kqee91

Trevlopoulos, N. S., Tsalis, T. A., Evangelinos, K. I., Tsagarakis, K. P., Vatalis, K. I., & Nikolaou, I. E. (2021). The influence of environmental regulations on business innovation, intellectual capital, environmental and economic performance. Environment Systems and Decisions, 41(1), 163-178. https://doi.org/10.1007/s10669-021-09802-6

Wang, L., & Zhang, B. (2025). Research on the green investment of traditional energy enterprises and its effectiveness under environmental regulation. Sustainability, 17(2), 590. https://doi.org/10.3390/su17020590

Wu, L., Yi, X., Hu, K., Lyulyov, O., & Pimonenko, T. (2025). The effect of ESG performance on corporate green innovation. Business Process Management Journal, 31(8), 24-48. https://doi.org/10.1108/BPMJ-04-2023-0237

Wu, Y., & Tham, J. (2023). The impact of environmental regulation, environment, social and government performance, and technological innovation on enterprise resilience under a green recovery. Heliyon, 9(10), e20278. https://doi.org/10.1016/j.heliyon.2023.e20278

Yang, J., Zuo, Z., Li, Y., & Guo, H. (2024). Manufacturing enterprises move towards sustainable development: ESG performance, market-based environmental regulation, and green technological innovation. Journal of Environmental Management, 372, 123244. https://doi.org/10.1016/j.jenvman.2024.123244

Yu, X., & Atento, R. G. (2026). Training effectiveness and improvement strategies for motor vehicle safety and technical inspectors: Evidence from two vocational institutions in Fujian, China. Journal of Enterprise Strategy and Management Innovation (JESMI), 1(2). https://doi.org/10.65166/msxhtj07