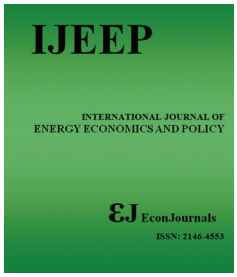

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2026, 16(1), 902-915.

Integrating Digitalization, Corporate Social Responsibility, and Human Capital for Environmental Sustainability: The Strategic Role of Green Finance in Commercial Banks

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Received: 27 July 2025 **Accepted:** 28 November 2025 **DOI:** https://doi.org/10.32479/ijeep.22006

ABSTRACT

This study investigates the determinants of environmental sustainability (ES) within the banking sector of emerging economies, focusing on the roles of employee green behavior (EGB), corporate social responsibility (CSR) initiatives, and green innovation (GI). It further examines green finance (GF) as a mediating mechanism through which these factors influence environmental sustainability, while financial technology (FinTech) is explored as a moderating variable that may strengthen or weaken these relationships. Empirical data were collected from 385 branch managers in the banking industry through a combination of self-administered and online survey questionnaires. Partial least squares structural equation modeling (PLS-SEM) was used to analyze the direct and indirect correlations between the variables. The findings indicated that banks' environmental sustainability was positively and significantly impacted by their sponsorship of green projects. Furthermore, it was found that banks' sustainable performance is improved by CSR initiatives and green employee behavior, and that FinTech does not moderate the relationship between environmental sustainability and green innovations through the mediation of green finance. This study is unusual because it examines the combined effects of employee green behavior, green innovations, CSR initiatives, green financing, and Fintech adoption on sustainability—an area that hasn't gotten much attention in previous research. In particular, this study supports the 2030 Agenda for Sustainable Development by showing how financial technologies and sustainable banking practices help achieve SDG 9 (Industry, Innovation, and Infrastructure) and SDG 13 (Climate Action), two UN Sustainable Development Goals.

Keywords: Green Innovations, Employee Green Behavior, CSR Activities, Green Finance, Financial Technology (FinTech), Environmental Sustainability
JEL Classifications: G21, Q53, Q56, O13, C32

1. INTRODUCTION

Sustainable development has become a major global priority thanks to the Sustainable Development Goals (SDGs) and the United Nations' 2030 Agenda. This agenda is advanced in large part by financial institutions, particularly banks, through capital allocation, responsible financing, and the promotion of environmentally friendly practices. The primary SDGs that this study supports out of the 17 are SDGs 9 (Industry, Innovation, and Infrastructure) and 13 (Climate Action). By combining environmental sustainability, green finance, employee green behavior, FinTech, and green innovation, banks may play a vital role in assisting in the accomplishment of these objectives.

Any economy is significantly impacted by the banking industry's financial performance. The importance of the industry and the

widespread impact of its issues on all economic units were clearly demonstrated by the global financial crisis of 2008 (Evci et al., 2024). The balance sheets of financial institutions are impacted by financial stability, which also has a positive effect on climate change. The development of models is necessary for the efficient management of climate change-related financial risks. The banking industry's significance to sustainable development is demonstrated by its capacity to provide funding for green initiatives and influence companies to adopt green practices. Sustainability can be accelerated by the financial sector by funding renewable energy and environmentally beneficial initiatives. This two-pronged strategy aligns with global sustainability goals and supports the banking sector's role as a catalyst for green innovation and sustainable economic growth (Hariyadi et al., 2025). For instance, by funding initiatives that reduce environmental damage and reduce the risks associated with climate change, green finance directly supports SDGs 12 and 13 (Zhang et al., 2019). Climate change is positively impacted by financial stability, which also has an effect on financial institutions' balance sheets.

There is a financial risk associated with climate change, and models should be developed to handle these risks (Siregar et al., 2025). FinTech innovations also help achieve SDG 9 by facilitating innovation, efficiency, and digital infrastructure in banking institutions (Shen et al., 2021). A recent study highlights how crucial green banking is becoming to bringing financial practices into line with the SDGs (Bilal et al., 2024). Khan et al. (2023), for example, showed that sustainable banking practices are in line with international sustainability standards and directly aid in the accomplishment of national environmental goals.

For regulators to accomplish the Paris Agreement and the Sustainable Development Goals (SDGs), particularly in poorer nations, fintech and green finance are crucial (Nassiry, 2019). One of the most important ways to reduce inequality and enhance environmental sustainability is to establish a reliable and effective digital payment system both domestically and internationally. Banking institutions are greatly promoting the sustainable development of the country by utilizing cutting-edge technologies like blockchain, green banking, and online banking (Siddik and Zheng, 2021) and supporting a variety of green initiatives, such as energy efficiency, clean technology, renewable energy, and the growth of green industries (Chen et al., 2022).

Therefore, the primary focus of this study is on the variables influencing the environmental performance of banking institutions in a developing nation such as Pakistan. Although technical innovation, environmental sustainability, and economic growth are not new topics, it is increasingly important to include them in a single study (Akter et al., 2018). The acronym fintech stands for "companies or enterprises that integrate cutting-edge, innovative technology like blockchain with financial services" (Dorfleitner et al., 2017). The use of technological innovation to provide individuals with financial services and products is known as fintech (Dwivedi et al., 2021).

One of the most important factors in making an organization more is employee green behavior (Yong et al., 2020). Recent studies show that little is known about how EGB and green service behavior are related, which is crucial for empirical research (Rubel et al., 2021). This study uses structural equation modeling to investigate green banking practices, concentrating on how CSR, employee green behavior, and green innovation relate to environmental sustainability. It investigates the relationships between environmental sustainability, green innovation, EGB, CSR initiatives, green finance, FinTech, and branch managers of commercial banks using primary data. This research is unique in any global context.

2. REVIEW OF LITERATURE AND DEVELOPMENT OF HYPOTHESES

2.1. Environmental Sustainability and Green Innovation

The results of Wang et al. (2020) on green innovation, endorse the idea that there is a good correlation between green purchasing and working with clients who are in GI or EP. According to certain data, GP and environmental cooperation (De Roeck and Farooq) improve manufacturing enterprises' EP by influencing the behavior of suppliers and customers in a sustainable and eco-friendly manner (Li et al., 2024; Long et al., 2022). By keeping an eye on and training suppliers, businesses may be able to offer environmentally friendly products, boosting their EP (Sarfraz et al., 2023).

By concentrating on GI, which employs environmentally friendly production techniques, businesses may increase productivity and utilize less resources, which will ultimately lower overall expenses (Iftikhar et al., 2024). Chen and Hung (2014) For example, by cutting waste and improving material efficiency, eco-design (ECO), a component of GI, has been shown to result in cost reductions that have a major impact on the business's environmental performance. Additionally, Yang et al. (2021) noted that ECO practices are a substantial benefit that overcomes the expenditures associated and that they significantly contribute to cost reductions through the higher possibility of selling items abroad.

Ramli et al. (2025), examines the connection between sustainable development, green technology, and green growth. In general, GI practices have been shown to improve a company's brand identity, foster ethical behavior, guarantee safety, give equal opportunities, and boost consumer loyalty (Kraus et al., 2020). Even while there aren't as many empirical studies on the connection between GIs and SPs, what is known indicates that eco-friendly business practices could help increase consumer loyalty and strengthen a company's brand identity (Asadi et al., 2022). Thus, the following theory is put forth.:

H_1: Environmental sustainability is significantly impacted by green innovation.

2.2. Green Financing and Green Innovation

Green finance encompasses a variety of financial products and services, including fiscal policy, green insurance, green bonds, green funds, and green credit. The norms and tenets of financial

institutions' green credit programs were spelled out in detail in the 2012 Green Credit Guidelines. According to Hao et al. (2024), in more market-oriented areas, especially in developing nations, green credit policies benefit major polluters. The green credit policy has a considerable positive impact on high-performance businesses (HPFs), mostly through tighter lending limitations. Companies can raise their stock value by issuing green bonds, which also help them perform better environmentally (Zhou and Cui, 2019).

Corporate green bonds, on the other hand, solely benefit current owners and do not command a high premium. Several studies look at the effects of green finance policies from the viewpoint of those who carry them out most frequently. Green credit works well to increase banks' fundamental competitiveness and credit risk management (Luo et al., 2021). The minimal premium currently offered for corporate green bonds, it has been countered, is insufficient to persuade investors to support the green bond market more. The focus of current research is on individual financial instruments. There aren't many studies that assess and look at the entire green finance policy (Akomea-Frimpong et al., 2022). To sum up, there is a dearth of pertinent research on green innovation in businesses.

Green technology innovation that uses less energy and raw materials and lessens environmental pollution is the main focus of research on green innovation, which began in the 1990s. The term "green technology" and its definition frequently change based on the subject of the study, such as eco-innovations, energy-efficient technologies, renewable energy technologies, and environmentally friendly technologies. Technologies connected to climate change mitigation and ecologically relevant pollutant disposal are among the widest categories of green innovations as defined by the World Intellectual Property Organization (WIPO). Hojnik and Ruzzier (2016) held that corporate structure, market-oriented policies, and command-and-control policies are the primary determinants of organizations' green innovation.

Wang and Chang (2014) verified the function of policy tools and investigated how different tools affected various industries and technologies. Businesses' innovation practices and profitability are linked. The company's legitimacy pressure can be influenced by its profitability, which can positively influence the development of green products (Li et al., 2017). Hence, we formulate the following hypothesis.

H_2: Green innovation significantly influences the sources of green finance.

2.3. Sustainability of the Environment and Green Finance

Natural resources are fundamental to businesses, providing energy and raw materials, which is only possible in a sustainable environment (Ramli et al., 2025). Green finance and corporate social responsibility are ways for businesses to be accountable to their stakeholders, which include the general public, shareholders, investors, consumers, and other groups. According to Xu and Zhu (2024), these practices help businesses achieve sustainable and profitable outcomes while avoiding social and environmental conflicts and legitimacy gaps. However, some believe that GF (Green Finance) systems may eventually compromise environmental and social responsibilities (Indriastuti and Chariri, 2021). Indriastuti and Chariri (2021) claim that by promoting a variety of eco-friendly projects that significantly affect environmental performance, green finance can improve corporate sustainability in a company (Chen et al., 2022).

Nonetheless, Wahba and Elsayed (2015) asserted that corporate social responsibility (CSR) investments might significantly benefit businesses and society, improving the company's sustainability and financial performance Feng et al. (2022) as well as its EP (Kraus et al., 2020). Recent research has shown that GF significantly enhances banking organizations' environmental performance (Chen and Hao, 2022). An organization's corporate responsibility and environmental performance can be enhanced by funding a range of eco-friendly initiatives. As a result, the subsequent research hypothesis is developed. This leads to the formulation of the following research hypothesis:

H_3: Environmental sustainability is significantly impacted by green finance.

2.4. CSR Activities and Environmental Sustainability

While many scholars have studied the relationship between corporate social responsibility (CSR) and financial and non-financial performance, few have studied the relationship between CSR and environmental performance in the context of developing countries (Suganthi, 2020). More recently, Suganthi (2020) examined the relationship between environmental performance and corporate social responsibility for sustained commercial success. According to the report, corporate social responsibility (CSR) initiatives significantly improve an organization's environmental performance by enabling it to evaluate its operations and motivating staff to cut back on solid and liquid waste. The likelihood of long-term sustainability, cost savings, and enhanced quality, flexibility, and delivery is higher for companies who support CSR efforts (Famiyeh, 2017).

Additionally, Ait Sidhoum and Serra (2017) looked into how CSR related to a variety of performance metrics across US electric utilities, like social, economic, environmental, and governance. The study found a high correlation between economic and social performance and economic and environmental performance. Additionally, it said that eco-friendly technology will support financial well-being and contribute to the creation of a better environmental system, which will enhance sustainability and economic results. Additionally, environmental performance is significantly impacted by how CSR is perceived (Channa et al., 2021). However, there was no appreciable impact of CSR on environmental performance (Kraus et al., 2020). Management's dedication to corporate social responsibility (CSR) can enhance environmental performance by lowering contamination and material waste during production, resulting in recyclable products (Rivera et al., 2017). According to this study, corporate social responsibility (CSR) activities are efforts that "organizations undertake for the benefit of society and the environment to

achieve overall organizational performance, including the environmental performance." As a result, the following theory has been established:

H_4: The environmental performance of banks is positively impacted by CSR initiatives.

2.5. CSR Activities and Green Finance

There is a long and complex history behind corporate social responsibility (Saeidi et al., 2021). However, it became well-known in the 20th century, particularly in the early 1950s, and in recent years, both companies and academics have paid attention to it (Carrington et al., 2019). CSR refers to strategies employed by companies or groups to conduct their activities in a way that is ethically sound, socially responsible, and advantageous to the advancement of the community (Mocan et al., 2015). Funding environmentally conscious businesses, volunteering, and reducing carbon footprints are some of the most important CSR activities that banks undertake (Mocan et al., 2015). Thus, it can be claimed that businesses are pursuing CSR initiatives for the benefit of society and the environment to achieve overall organizational success and sustainability. GF has become very popular since its inception in the economic conversation between state governments and international organizations (Wang et al., 2019). A novel financial model called GF places a strong emphasis on green investments to save the environment and promote prosperity. It has also become more well-liked among researchers, practitioners, scholars, and academics (Zhang et al., 2021). Significantly influencing the development of a balanced is seen as a crucial component of sustainable banking, having a significant influence on the development of a balanced economy and markets generally (Akter and Akhter, 2018). According to Environmental, Social, and Governance (ESG) criteria—that is, elements that are essential to long-term economic growth and finance—GF is a comprehensive strategy that integrates several initiatives to improve the monetary system's economic, social, and environmental performance (Zheng et al., 2023). Akhtar et al. (2024) note that green bonds, microfinance, sustainable funds, impact investments, active ownership, credits for environmental sustainability, and the improvement of entire financial systems are among the GF's primary activities. "GF" stands for "Triple Bottom Line," a framework that encompasses three dimensions: social, economic, and environmental factors (Zheng et al., 2021). For example, GF parameters are uniquely identified in most research. Nevertheless, only a small number of studies have looked at the connections between the social, economic, and environmental elements of GF in the banking industry (Akter et al., 2018). Zheng et al. (2021) recently studied GF's expansion in Bangladesh's banking sector, particularly in PCBs. In order to effectively implement GF in Bangladesh and support the nation's long-term ecodevelopment, they discovered that bankers at PCBs possessed an adequate degree of knowledge, insights, and understanding of the key components of GF and green finance. Important sources of green financing by financial institutions were also identified in the survey, including waste management, the expansion of the green sector, energy efficiency, renewable energy, alternative energy, and so on.

H_5: CSR initiatives positively affect the banks' green financial sources.

2.6. Sustainability of the Environment and Green Behavior by Employees

Ones et al. (2018) demonstrate how EGB is a measurable personal behavior that has a positive or negative impact on environmental sustainability goals within the context of an employee's work. EGB includes trash reduction, electricity saving, paper recycling, double-sided printing, and the use of energy-efficient equipment. Several investigations have been conducted on the topic of EGB, e.g., (Norton et al., 2015). ecologically friendly, ecologically sustainable, and responsible environmental behaviors are examples of pro-environmental behaviors, which are relative individual good activities for environmental enrichment (Safari et al., 2018). According to DuBois and Dubois (2012), One tactic used by businesses to enhance their performance in terms of environmental sustainability is EGB. The demands of the natural environment affect the daily lives of employees, making it difficult for a business to provide for their well-being (such as water, heating/cooling, transportation, etc.) while still obtaining the best possible production from them. This suggests that emotional strain brought on by environmental demands affects how well employees perform at work (DuBois and Dubois, 2012)

According to Norton et al. (2015) EGB describes how employees (both required and voluntary) behave at work to protect the environment by lowering negative aspects of the ecosystem and/or enhancing positive ones. EGB behavior can be divided into two categories: Employee conduct might be either obligatory or voluntary (DuBois and Dubois, 2012).

Sustainability performance is a phrase that combines three variables, referred to as the Triple Bottom Line, in relation to a) economic, b) social, and c) environmental factors. Remarkably, the Triple Bottom Line dimensions have been uniquely recognized in the majority of projects. But few studies examine how these social, environmental, and economic aspects are interconnected (Basiago, 1998). Economic dimension: An organization's profitability and expansion are terms used to describe its economic performance (Judge and Douglas, 1998). Environmental dimension: Judge and Douglas (1998) define environmental performance as a company's ability to both meet and surpass societal standards for environmental consciousness. Beyond simply adhering to current laws, this goal also includes taking a proactive approach to future environmental concerns. An organization's environmental performance encompasses the quantity of resources it consumes for operations, including energy, land, and water, as well as the outcomes of those activities, such as waste, air emissions, chemical residues, and effluents. Environmental performance evaluation is still quite limited since it focuses mostly on immediate environmental impacts, such as waste production, pollutant emissions, energy use, and the depletion of natural resources, rather than the long-term environmental effects of businesses' operations (Kestane and Sezgin, 2022).

Social dimension: "A business organization's configuration of principles of social responsibility, processes of social responsiveness, rules, programs, and observable outcomes as they relate to the firm's societal relationships" is what is meant by social

performance (Wood, 1991). Social performance encompasses the impact that businesses (and their suppliers) have on the communities in which they operate. It encompasses, among other things, employee relations, health and safety, compensation to control living expenses, nondiscrimination, staff turnover rate, professionalism, and education (Kestane and Sezgin, 2022).

H_6: The environmental performance of banks is greatly impacted by employee green behavior.

2.7. Green Finance and Green Employee Behavior

According to Chen et al. (2023) Employee green behavior and green finance are directly related. According to a study by Zhang et al. (2021), the Green Credit Policy (GCP), which seeks to promote short-term lending to businesses that affect the environment, might not have the intended impact. Short-term revenue increases could result from it, but long-term consequences could make investments in environmental upgrading more difficult. Employees may be unintentionally discouraged from engaging in green practices as a result.

According to research, a positive person-organization fit can encourage green behavior from employees, especially when it comes to values (Mi et al., 2020). Employees are more inclined to adopt green activities when they believe their values match the company's environmental commitment, which is demonstrated via Green Finance practices. Furthermore, the greater the positive impact on employees' green behavior, the more closely they identify with the organization's environmental aims (Mi et al., 2020). Research demonstrates a positive correlation between green finance and employee green behavior, supporting the following concept.

H_7: The sources of green finance are greatly influenced by employee green behavior.

2.8. Green Innovation, Green Finance, and Environmental Sustainability

In order to promote sustainable development and guarantee a more resilient future, green finance refers to the flow, support, or investment in a project that lowers carbon emissions (Neale et al., 2021). Therefore, by reducing carbon emissions, green finance is a more effective financial strategy for halting environmental degradation (Meo and Abd Karim, 2022). The major sources of carbon dioxide emissions, which contribute to environmental pollution due to global warming, are fossil fuels such as natural gas, oil, and coal (Jama and Abdi, 2025). Böhringer et al. (2015) discovered that investment in promoting the use of renewable energy and innovation in the energy sector is necessary to ensure environmental sustainability. Sufficient green financial flows are a necessary condition for further green technology research and development, which together reduce CO2 emissions and help to accomplish SDGs 7 and 13 (Afzal et al., 2022). Thus, in this research, we examine how green finance functions as a mediator between environmental sustainability and green innovation.

Because companies usually prefer to finance technical innovation over scale development, and governments support the rise of green financing, the industry has helped to lessen the impact of carbon emissions (Ismail et al., 2025). Moreover, strong governance promotes development (Khan and Ghouri, 2022). It draws the FDI required for the improved and more efficient use of green financing to lessen the effects of climate change. To reduce carbon emissions and improve environmental sustainability, sound institutional quality aids in the creation of environmental policies, rules, regulations, and legislation (Haldar and Sethi, 2021). Therefore, we evaluate how green innovation and green finance interact to affect environmental sustainability. We put out the following theory:

H_8: The relationship between environmental sustainability and green innovation is mediated by green finance.

2.9. Green Finance as a Mediator between Environmental Sustainability and CSR Activities

According to research, a company's productivity can be increased by incorporating CSR into its daily operations (Rinawiyanti et al., 2023). According to Kraus et al. (2020), when evaluating corporate social performance in research, especially concerning SMEs, a number of stakeholders and indicators must be taken into account. These include working conditions, hazardous emissions, stakeholder interactions, and other environmental and social problems (Akhtar et al., 2023). It is essential to look at sustainable performance, which encompasses social, environmental, and financial factors, in tandem with corporate social responsibility. Studies show that environmental abilities are improved by corporate social responsibility (CSR), leading to a sustained competitive advantage. An organization's ability to lessen its environmental effect through sustainable practices is known as sustainable environmental performance (Ali et al., 2019).

According to the natural RBV theory, using CSR as a resource can improve a company's environmental performance (Rehman et al., 2022). This study promotes more investigation into the connection between SEP and CSR. According to Briones Peñalver et al. (2018) CSR activities that aim to improve economic performance must prioritize innovation. Chuang and Huang (2018) found that environmental corporate social responsibility (CSR) has a major impact on green IT capital, which is made up of relational, structural, and human capital. For SMEs, environmental responsibilities and competencies are essential. The purpose of this study is to bridge the gap in the assessment of green capabilities brought about by CSR. Effective CSR practices can help companies gain the respect and good name of all parties involved, including workers. Therefore, we come up with the following theory.

H_9: Green finance acts as a mediator in the interaction between banks' environmental performance and their CSR initiatives.

2.10. Employee Green Behavior and Environmental Sustainability are Mediated by Green Finance

Green behavior is characterized by De Roeck and Farooq (2018) as environmentally friendly practices, such as recycling, conserving resources, taking part in environmental projects, and encouraging sustainable endeavors. Green conduct is the term for conscientious or environmentally friendly practices that emphasize the value of environmental sustainability, such as recycling and reducing waste (Usman et al., 2023). In response to the escalating environmental concerns of today and the implementation of stricter environmental

laws in numerous nations, businesses are promoting more ecologically conscious behavior among their staff members (Bell and Russell, 2002). Understanding the effects of environmental initiatives makes people more open to them.

Before implementing eco-friendly procedures and making a sustainable contribution, staff must be made aware of the repercussions of their activities for green banking practices to be successful (Khan et al., 2023). A bank's sustainability strategy and performance are built on employee green behavior, which stems from actions that have a beneficial environmental impact (Iqbal et al., 2018). Green behavior is defined by De Roeck and Farooq (2018) as environmentally friendly practices, including recycling, conserving resources, participating in environmental projects, and promoting sustainable endeavors.

Companies are promoting environmentally conscious behavior among their staff as a result of growing environmental concerns and stricter environmental laws being put into place in several nations (Saeed et al., 2019). People are more receptive to environmental behaviors once they are aware of their implications. For green banking projects to succeed, employees must understand the consequences of their actions before putting eco-friendly practices into place and promoting sustainability (Bukhari et al., 2020). The foundation of a bank's sustainability strategy and performance is employee green behavior, which results from activities that positively affect the environment (Saeed et al., 2019).

H_{10}: Environmental sustainability and EGB are mediated via green finance initiatives.

2.11. The Moderating Effect of Fintech through GF Mediation on the Relationship between Environmental Sustainability and Green Innovation

Businesses' environmental performance is significantly impacted by FinTech adoption (Bhuiyan et al., 2024), which reduces carbon emissions and physical labor while promoting the utilization of sustainable energy sources and enhancing resource efficiency (Ashta, 2023). Furthermore, FA can raise EP by offering environmentally friendly financial services and goods (Liu et al., 2022).

Therefore, Guang-Wen and Siddik (2023) argue that to improve an organization's EP, FinTech adoption should be connected to its environmental management procedures. A study of the literature shows that there are still few studies that have examined how FA affects BEP, as most prior research focused on how FA affects banks' FP (Yan et al., 2023) and accomplishment that is not monetary (Lamey et al., 2024). In their investigation, Guang-Wen and Siddik (2023) examined the impacts of GI as a mediating factor between FA and GF and BEP in Bangladesh. They found that GI mediates the link between FA, GF, and BEP and that both FA and GF have a significant and positive impact on BEP. These theories suggest that no research has looked at the connection between FA and BEP in developing ME nations. In order to confirm that FA can support BEP as a method for environmental modernization, this study uses EMT. The following hypothesis is generated:

H_{11}: Green finance acts as a mediator between green innovation and environmental sustainability, and the adoption of fintech moderates this link.

2.12. The Conceptual Framework

The image below shows the proposed conceptual framework for the investigation. The conceptual research model was developed based on the theoretical foundations and a study of contemporary research on green banking, green leadership, green finance, GHRM practices, FinTech, and the sustainable performance of banking organizations.

3. MATERIALS AND METHODS

3.1. Design of the Research

The design of the study was guided by the theoretical foundations of the research, utilizing a reflective model with GI, CSR, and EGB as independent variables (IVs), FinTech as a moderator, Green Finance as a mediator, and Environmental sustainability as the dependent variable. When constructs are thought of as latent variables that represent the underlying theoretical frameworks, reflective models perform at their best (Coltman et al., 2008). Environmental performance, EGB, and CSR are all complex concepts that are derived from quantifiable data rather than being immediately obvious. The study improved the validity and reliability of the research findings by using a reflective technique to ensure that the assessment of these constructs appropriately reflected their theoretical notions. Reflective models provide for a more thorough examination of the mediation and moderation effects in the suggested model as well as a greater comprehension of the connections between the constructs.

3.2. Data and the Sample

The study's target population consisted of bank managers nationwide. Branches of the nation's banks completed the survey within the allotted time because the study's participants were administrators. Based on (Andersen et al., 2012) criterion for unconstrained population sampling, the study used a stratified sampling strategy to guarantee a representative sample. The sample size was determined by selecting 385 branch managers based on the criteria set by (Morgan and Shaw, 1970) for determining the minimum sample size.

A standardized questionnaire designed to satisfy the unique needs of the banking industry served as the main tool for data collection. This questionnaire was carefully crafted to gather comprehensive information relevant to the study's objectives. The researcher gave the managers the choice to complete the questionnaires manually (using a paper instrument) or electronically (using Google Forms) in order to expedite the data gathering process. After obtaining their consent, the respondents were given the questionnaires. The data collection method required more than 3 months to provide a timely and significant response rate. The exercise was finished on September 30, 2025, having started on July 1, 2025. Most of the activity was completed in the time given to the respondents. The exercise was finished with the help of experienced field assistants. The assistants could assist with the answers if needed because they had complete control over each question.

Following the collection of enough participant data, the data underwent a thorough analysis to remove or drastically reduce

any inaccuracies brought on by missing or incorrectly completed questionnaires. After that, the data was meticulously coded to remove any instances of missing data. The Statistical Package for Social Sciences and Smart PLS-SEM tools were used to code, process, and analyze the data. Informed permission and other ethical considerations were considered before the distribution of the surveys. All confidentiality and plagiarism policies were adhered to, and the researcher collected the data alone. Following the conclusion of the study, participant data were securely stored on Google Drive and deleted. The surveys were given to the general public and media only for research purposes, and no identifying information was included. The measurement of the variable constructs was based on earlier studies (Table 1).

3.3. Measures of Constructs

To ensure content validity, all constructs were assessed using validated multi-item measures modified from earlier research.

Table 1: Study variable measurements

Variable	No. of items	Measurement source
Green Innovation	5	Chen et al., 2006
CSR activities	7	e Roeck and Farooq, 2017
Green Finance	6	Chen et al., 2022
Environmental Sustainability	4	Malik et al., 2021
FinTech Adoption	4	Yuan, 2025
Employee Green Behavior (EGB)	6	De Roeck and Farooq, 2018

4. FINDINGS AND INTERPRETATION

The use of structural equation modeling, which incorporates higher-order components, is a helpful method for estimating complex models. A measurement model evaluation must be performed first to ensure accurate interpretation. As indicated in Table 2, this includes evaluating the model's reliability and convergent validity. Components with loadings greater than 0.7 are retained when we use factor loadings to quantify dependability. A construct's conceptual domain can be represented by an object, as shown by these loadings. Loadings above 0.7, as recommended by Cheah et al. (2018). It shows high internal consistency, which guarantees that test items evaluate the same concept consistently.

Composite reliability (Neale et al., 2021) and rho-A are the two diagnostic techniques used in this study to evaluate the dependability of internal consistency. The shared variance between the observable variables and the latent construct indicators is measured by the composite reliability, which is regarded as a trustworthy indicator in PLS-SEM (Sarstedt et al., 2016) and (Fornell and Larcker, 1981). A CR of 0.60 to 0.70 may be used for exploratory research, but a CR of >0.708 is required to pass the test.

4.1. Convergent and Discriminant Validity Tests

Although it was customary to eliminate reflected indicators with loadings of less than 0.700 from the measurement model, certain authors of flexible criteria occasionally support factor loadings greater than 0.6 (Hulland, 1999). The indicator reliability test was conducted along with tests for discriminant and convergent

Table 2: Evaluation of measurement constructs for convergent validity and reliability

Variables	Indicators	Factor loading	rho_A	Composite reliability (rho-C)	AVE	Cronbach's alpha
Green Innovation	GI1	0.752	0.880	0.911	0.672	0.877
	GI2	0.784				
	GI3	0.864				
	GI4	0.862				
	GI5	0.832				
Employee Green Behavior	EGB1	0.826	0.909	0.932	0.733	0.909
	EGB2	0.844				
	EGB3	0.893				
	EGB4	0.878				
	EGB5	0.840				
Green Finance	GF1	0.804	0.866	0.905	0.658	0.868
	GF2	0.845				
	GF3	0.858				
	GF4	0.842				
	GF5	0.694				
CSR Activities	CSC1	0.767	0.889	0.908	0.585	0.882
	CSC2	0.806				
	CSC3	0.677				
	CSE1	0.732				
	CSE2	0.754				
	CSE3	0.791				
	CSE4	0.815				
Environmental Sustainability	ES1	0.781	0.766	0.845	0.578	0.685
	ES2	0.844				
	ES3	0.732				
	ES4	0.675				
Financial Technology	FA1	0.845	0.846	0.896	0.755	0.844
	FA2	0.871				
	FA3	0.871				
	FA4	0.714				

validity. The frequently-retrieved variance and the outer loadings of the indicators were also calculated. Until the hidden variable explains at least 50% of each indicator's variance, no conclusions can be made. An external loading of greater than 0.5 squared, or 0.708, was predicted. According to the theory of convergent validity, measurements of the same construct have a higher chance of correlating with the underlying construct than measurements of distinct constructs. given that an average variance extracted (AVE) is present for every element in Table 2.

Convergent validity is proven by any score that is greater than 0.5. Discriminant validity was evaluated using a diagnostic test using the heterotrait-monotrait correlation ratio (HTMT) and cross-loading measures (shown in Tables 2-4) as evaluation criteria. To prove discriminant validity, the cross-loading technique is described by Henseler et al. (2015) as the weak correlation between a construct indicator and every other construct, except the one with which it is most closely connected. Cross-loadings are used to attain discriminant validity, and the results in Table 2 show that the loadings of the indicators on their parent constructs are stronger than the loadings on the alternative constructs. These cross-loading values are produced using the PLS algorithm technique (as shown in the table), and their discriminant validity can be evaluated. The results in Table 3 further reinforce the propriety of using cross-loadings to demonstrate discriminant validity because the indicators' initial constructions have loadings that are stronger than the cross-loadings on the other constructs.

The HTMT and cross-loadings were used to assess an indicator's discriminative validity (Table 3). There is no discriminant validity if the HTMT's end value is close to one, which is seen as more reliable. Henseler et al. (2015) suggests 0.90 as the threshold value. However, a lower, more conservative threshold value of 0.85 is advised for conceptually more complex concepts (Henseler et al., 2015). Consequently, when the HTMT ratio is less than 0.85, indicators are quite good at differentiating between builds. As Table 3 illustrates, all HTMT values are below 0.9, and most of them satisfy the more stringent cutoff of 0.85. The HTMT demonstrates that indicators significantly outperform the unrelated constructs in terms of loading on and discriminating on the parent constructs (Kline, 2018).

Table 3: Discriminant validity using heterotrait-monotrait ratios

Construct	CSR	EGB	ES	FA	GF	GI
CSR						
EGB	0.676					
ES	0.812	0.778				
FA	0.710	0.840	0.831			
GF	0.745	0.732	0.828	0.789		
GI	0.666	0.770	0.772	0.900	0.698	

Source: Authors' own elaboration from SmartPLS

Table 4: Variance inflation factors for evaluating multicollinearity

Constructs	VIF	Interpretation
GI→Environmental Sustainability	3.103	Moderate correlation; acceptable
GI→GF	2.086	Low to moderate correlation; acceptable
GF→ES	2.115	Low to moderate correlation; acceptable
CSR→GF	1.759	Low correlation; very good
EGB→ES	2.401	Moderate correlation; acceptable
EGB→GF	2.157	Moderate correlation; acceptable
FA×GF→Environmental Sustainability	1.358	Very low correlation; excellent

Source: Authors' elaboration from SmartPLS

4.2. Collinearity Diagnostics

Additional evaluations of the route model's predictive power, the overall impact of the exogenous components, effect size, collinearity, relevance, and importance of the structural model were conducted. We conducted an initial test to ensure accurate path coefficient estimation in the structural model and to prevent any issues with collinearity. We received assistance from Hair et al. (2017), who stated that the presence of collinearity issues is indicated by a large fraction of VIF values > 5. According to a different, stricter standard put forward by Becker, a VIF value of 3 or less is preferred (Duarte and Amaro, 2018).

4.3. The Structural Model

As the structural model image illustrates, GI, CSR, GF, EGB, and ES are all related. Green finance and sustainable performance are positively impacted by GI, CSR, and EGB, according to the results.

Figure 2 shows a representation of the structural model.

4.4. Test for the Moderating Impact

The moderator establishes the conditions necessary for a forecast and an outcome variable to be related. This implies that a moderating variable influences the kind and degree of correlation between an outcome variable and a predictor. Moderators may be continuous and/or discrete (e.g., income or degree of reward) or qualitative and categorical (e.g., based on sex, race, or class), according to (Pokhariyal, 2019). Moderators can alter a prediction's influence on a result, either positively or negatively. The study's ultimate goal was to investigate how FA might lessen the correlation between green innovation and the banks' sustainable performance. A bootstrapping method was used to assess the importance of the moderating hypotheses; Table 5 displays the findings.

4.5. Mediation Test

In a mediation analysis, a third variable—referred to as the mediating variable—is inserted between two connected constructs (Hair Jr et al., 2017). By establishing a link between the independent and dependent variables, this mediating variable validates them. The outcomes of several direct and indirect impacts are displayed in Table 5.

4.6. Results of Hypothesis Testing (Particular Indirect Effects and Direct Effects)

Direct and indirect effects of the relationships are explained as follows:

4.6.1. Direct Effects

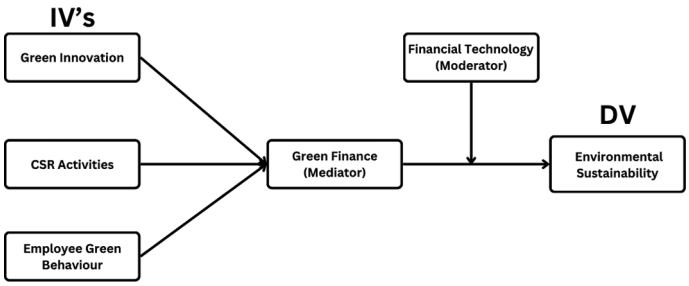
- Green Innovation (GI → ES)

No significantly beneficial effect for ($\beta = 0.146$, $P = 0.101$).

Table 5: Direct and indirect effects on environmental sustainability and their path coefficients

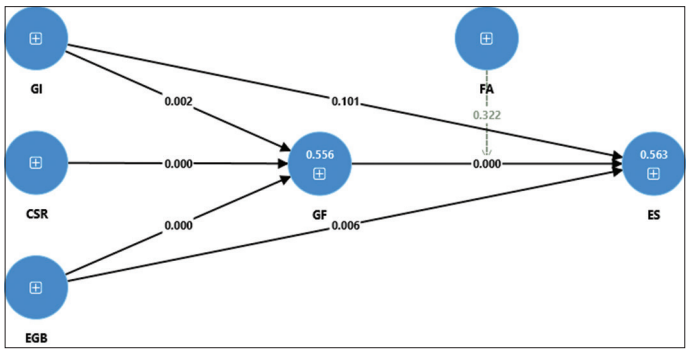
Relationship	Path coefficient	SE	T statistic	P-values
Green Innovation→Environmental Sustainability (β1)	0.146	0.089	1.638	0.101
Green Innovation→Green finance (β2)	0.190	0.060	3.167	0.002
Green finance→Environmental Sustainability (β3)	0.365	0.055	6.629	0.000
CSR→Environmental Sustainability (β4)	0.134	0.032	4.211	0.000
CSR→Green Finance (β5)	0.367	0.050	7.362	0.000
EGB→Environmental Sustainability (β6)	0.202	0.073	2.773	0.006
EGB→Green Finance (β7)	0.300	0.059	5.074	0.000
Green Innovation→Green finance→Environmental Sustainability (β8)	0.069	0.022	3.122	0.002
CSR Activities→Green finance→Environmental Sustainability (β9)	0.134	0.032	4.211	0.000
EGB→Green finance→Environmental Sustainability (β10)	0.110	0.027	4.052	0.000
Fintech Adoption×Green Innovation→Green finance→Environmental Sustainability (β11)	0.028	0.029	0.990	0.322

Figure 1: Conceptual model



Source: The Authors' own elaboration, which indicates a significant effect

Figure 2: Structural model



Source: Authors' elaboration from SmartPLS

- Green Innovation (GI → GF, β = 0.190, P < 0.001)

It demonstrates a notable positive impact, proving that green innovation increases the adoption of green finance. The resource-based view (RBV) is in line with this; internal practices act as intangible resources that promote innovative financial instruments.

- Green Finance (GF → ES)

Strong positive effects (β = 0.365, P < 0.001) are highly significant. This suggests that ES is directly influenced by GF instruments, such as green bonds, loans, and sustainable investments. Interestingly, the biggest connection is with ES, demonstrating how green finance specifically strengthens banks' competitiveness.

- CSR activities (CSR → ES)

Significant for (β = 0.134, P < 0.001). This implies that, in addition to enhancing operational and financial outcomes, executives' environmental vision is a critical factor in defining the social legitimacy of banks. CSR initiatives support the bank's reputation as a socially responsible business by fostering a pro-environmental corporate culture.

- CSR → Green Finance (β = 0.367, P = 0.000)

Highly significant. This argues that corporate culture and strategy alignment may have a more indirect effect in promoting the adoption of green financing

- EGB (EGB → ES)

Not significantly improved (β = 0.202, P = 0.006). It shows that encouraging green behavior among employees by training, rewards, and incentives enhances social outcomes and internal efficiency, but it might not instantly increase competitiveness. The AMO framework (Ability, Motivation, Opportunity) is in line with human capital development, where sustainability competencies influence long-term performance but do not always impact short-term competitiveness.

- EGB → GF (β = 0.300, P < 0.001)

very strong effect, demonstrating that the best indicators of the adoption of green finance are employee green skills and culture. This demonstrates that the primary force behind banks' shift to sustainable finance is human capital.

4.6.2. Indirect effects (mediation through green finance)

- GI → GF → ES

A significant indirect effect was observed. Shows a partial mediation: GI directly and indirectly supports ES through the use of green finance.

- CSR → GF → ES

It shows significant mediation (P < 0.001). It implies that CSR directly and indirectly enhances sustainable performance; its impact on green finance is strong.

- EGB → GF → ES

It shows strong mediation. Confirms that EGB builds capacity for green finance, which in turn drives ES. This verifies dynamic capability theory—EGB boosts absorptive capacity, enabling institutions to leverage green finance for sustainable results.

4.6.3. Moderated Mediation (FinTech Adoption × GI → GF → ES)
(β = 0.028, P = 0.322) shows no significant relationship.

Based on the explanation above, we deduce that the key to tying internal practices (EGB, GI) to sustainable performance is green finance. Although it is ineffective at enlisting green finance, CSR has the most direct impact. The most powerful facilitator of green finance is human capital (EGB), which reflects a people-driven approach to sustainability. Only competitiveness outcomes are moderated by fintech, demonstrating that digital innovation enhances market positioning more than operational or social consequences.

5. DISCUSSION

The study's findings show how green innovation, CSR, and employee green behavior (EGB) all contribute to banks' sustainable performance. The results show that whereas GI significantly enhances operational and financial performance, its impact on social performance is entirely mediated by green finance. This shows that although eco-friendly operations increase productivity and competitiveness, social legitimacy necessitates converting those practices into financial goods and services that further larger social objectives (Iftikhar et al., 2024).

On the other hand, EGB turns out to be a crucial facilitator of GF. In addition to strongly predicting GF adoption, EGB directly improves operational and social results by encouraging sustainability-oriented staff abilities and behaviors. This supports the claim that the cornerstone of dynamic sustainability capabilities is human capital. According to earlier studies, financial institutions are essential for striking a balance between social and ecological concerns and economic growth (Liu et al., 2022).

Green finance's mediating role, which promotes SDG 9 (Industry, Innovation, and Infrastructure), demonstrates its capacity to allocate resources toward environmentally responsible projects. By providing money for eco-innovations, renewable energy projects, and green technologies, banks promote ethical production and consumption practices as well as sustainable industrialization. These results support earlier studies that indicated green financing techniques are crucial for supporting systemic sustainability transitions in developing nations (Zhang et al., 2021).

FinTech's moderating role demonstrates its revolutionary potential for expanding sustainable financing and enhancing the effectiveness of green banking procedures. Since FinTech-enabled solutions like blockchain, artificial intelligence, and mobile banking improve transparency, lower transaction costs, and promote environmentally friendly financial flows, this aligns with SDG 13 (Climate Action). According to recent research, banks that use digital technologies in their sustainability policies not only enhance performance but also hasten the climate transition (Zhang et al., 2019).

Overall, by including employee green behavior, CSR activities, FinTech, and finance into banking operations, it results in a comprehensive sustainability framework; our findings advance both theory and practice. By advancing several SDGs at once, this framework provides a means for the financial industry to operationalize its contribution to the UN 2030 Agenda.

6. THEORETICAL AND PRACTICAL IMPLICATIONS

This study contributes to managerial practice and academic theory. It confirms multi-lens approaches theoretically by demonstrating the convergence of RBV, dynamic capability frameworks, and institutional forces in the explanation of sustainable banking. In practice, it offers useful information to legislators and financial professionals by highlighting the crucial role that green finance and FinTech play in attaining sustainable results.

6.1. Theoretical Implications

This research contributes to theory in a number of ways. In the first place, it goes beyond institutional theory by demonstrating that banks embrace GI and CSR not only for legitimacy but also because these practices enhance long-term results, especially when mediated through GF. Second, it links intangible sustainability practices with quantifiable performance outcomes by recognizing GF as a strategic resource that greatly boosts competitiveness, hence advancing the RBV. Third, it proves that EGB gives banks the absorptive capacity to use GF for better sustainability results, hence validating the dynamic capability idea.

Finally, the results show that FinTech increases the effect of GI on competitiveness, which validates contingency theory, implying that technology contexts influence how successful sustainability initiatives are. When taken as a whole, these contributions demonstrate that a multi-theoretical approach that incorporates institutional, resource-based, and contextual viewpoints is the most effective way to explain banking sustainability. Since it provides a theoretical framework for understanding how management and financial innovation support sustainable industrialization, this is consistent with SDG 9 (Industry, Innovation, and Infrastructure).

6.2. Practical Implications

The results also provide practitioners with helpful advice. Since the adoption of GF is highly predicted by employee green skills and values, bank management must invest in green human capital systems. Given their direct and important role in promoting legitimacy and competition, policymakers and regulators should provide frameworks and incentives that are favorable to green finance instruments. In order to build credibility, trust, and reputation, especially when it comes to improving social performance, management must enhance employee green behavior.

According to FinTech, technology-driven innovation is essential for scaling sustainable finance. This means that banks may more successfully support SDG 13 (Climate Action) by implementing digital transparency, green credit assessment, and effective green fund allocation.

7. LIMITATIONS AND FURTHER SCOPE

This study has limitations, even though it provides new insights. First, because the study was limited to one emerging economy (Pakistan), the results may not be as applicable to industrialized nations with distinct technological, cultural, and regulatory environments. Second, Future studies should use longitudinal designs to capture the dynamic evolution of GI, CSR, EGB, and GF over time, as the cross-sectional approach limits the capacity to demonstrate causality. Third, the study excluded other pertinent factors, such as GHRM, GBP practices, and organizational support systems that can affect sustainability outcomes in favor of concentrating mainly on GI, CSR, and EGB.

Fourth, FinTech was only studied as a moderator for the GI–GF–ES interaction; other studies should look into how it modifies the relationships between sustainability, HRM practices, and leadership. Lastly, even though this study used quantitative methods, qualitative or mixed-methods approaches might offer a more in-depth understanding of the difficulties banks encounter when implementing green policies.

Future research should compare emerging and developed economies, replicate this model in a variety of institutional and geographic contexts, and incorporate other factors including cultural values, regulatory pressures, and ESG reporting. These additions will deepen our comprehension of the ways in which banks attain sustainable performance and offer a more complete view of the financial sector's movement toward sustainability.

8. CONCLUSION

This study used FinTech adoption as a moderating factor and green finance as a mediating mechanism to investigate how CSR activities, employee green behavior, and green innovation affect banks' sustainable performance. Green banking methods improve economic and operational performance, but only green finance can realize their social impact, according to the findings. CSR was found to be the most powerful direct driver of social performance, highlighting its influence on corporate culture and legitimacy. The adoption of green financing was most effectively facilitated by employee green behavior, which not only enhanced operational and social outcomes but also demonstrated the critical role that human capital plays in developing sustainability capabilities. Importantly, by significantly enhancing all facets of sustainable performance, particularly competitiveness, which closely complies with SDG 9 (Industry, Innovation, and Infrastructure), green finance has confirmed its vital role in environmentally friendly banking systems.

According to the moderation study, the adoption of FinTech further illustrated the contextual value of technical innovation by fortifying the link between green innovation and competitiveness through green financing. The paper provides a thorough knowledge of how banks could achieve sustainable performance by integrating contingency theory, dynamic capacity theory, resource-based approach, and institutional theory. FinTech's moderating role highlights the value of digital innovation in expanding sustainable banking practices, which directly supports SDG 13 (Climate Action).

This study concludes by showing that the banking industry can catalyze systemic transformation. Banks can go beyond compliance and profitability to actively contribute to the UN 2030 Agenda for Sustainable Development by adopting sustainability-oriented practices and coordinating strategies with the SDGs.

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