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The Role of Green Finance in Enhancing the Sustainable Performance of Yemeni Banks in the Capital City of Sana'a

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ABSTRACT

Amidst political and economic instability, banks in conflict zones must adopt advanced frameworks to preserve institutional longevity. This study analyzes the role of green financing in driving sustainable performance across (six) Yemeni banks in Sana'a. Deploying an empirical methodology, we surveyed (236) banking executives selected through stratified random sampling from a total population of (789). Descriptive findings reveal a high level of green finance practice (78% agreement, M = 5.48) and relatively strong sustainable performance (69% agreement, M = 4.86). Crucially, formal regression highlights a statistically significant but paradoxically weak positive relationship ($\beta = 0.049$, $R^2 = 0.002$). Green finance accounts for a mere (0.2%) of performance variance, demonstrating that extreme environmental shocks like active warfare, hyperinflation, and severe infrastructural deficits completely dominate institutional outcomes. We conclude that while green initiatives are fundamentally vital, their immediate strategic efficacy is entirely neutralized without protective legislative guidelines, macroeconomic stabilization, and structural support in fragile developing nations.

1. Introduction

Sustainable performance has emerged as a pivotal managerial concept over the past two decades, particularly in response to the mounting economic and environmental challenges confronting institutions worldwide. This concept refers to an organization's ability to achieve financial efficiency while simultaneously considering environmental and social dimensions, thereby enhancing its continuity and generating added value for all stakeholders [6]. Within the banking sector, sustainable performance serves as a key indicator reflecting banks' capacity to deploy their financial and human resources effectively and sustainably, in alignment with international standards and global environmental requirements.

Concurrently, green finance has emerged as a strategic instrument supporting environmental sustainability and facilitating the transition toward a low-carbon economy. Green finance is defined

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as the provision of liquidity to fund projects that contribute to environmental protection, reduce carbon emissions, and improve the utilization of natural resources such as renewable energy and waste management initiatives [27 – 4]. Numerous studies have demonstrated that green finance not only mitigates negative environmental impacts but also enhances a bank's reputation and increases its appeal to investors and clients who prioritize supporting the green economy [1 – 29].

International bodies, such as the Financial Stability Board (FSB), emphasize the necessity of redirecting the global financial system toward supporting environmental sustainability by channeling investments into environmentally friendly products and services, thereby advancing the achievement of the Sustainable Development Goals [18]. Consequently, the role of banks in supporting the green transition through green financing instruments becomes increasingly critical particularly in economically fragile contexts such as Yemen, where banks face significant challenges stemming from political and economic instability.

Green finance is further defined as the provision of financial liquidity through financial products and services such as green loans, green bonds, and environmentally friendly investments to fund projects that contribute to environmental protection and reduce the carbon footprint [3, 28]. Some scholars also describe it as aiming to strike a strategic balance between meeting individuals' needs for goods and services and preserving natural resources for future generations [33].

Amid growing international pressure to redirect capital toward activities with positive environmental impacts, it has become imperative for Yemeni banks to reassess their investment priorities and develop innovative mechanisms that integrate environmental sustainability criteria into their financing operations. [1] highlighted the importance of establishing an independent sustainability management unit within banks to implement green banking initiatives and provide financing for environmentally friendly projects through innovative financial instruments.

Nevertheless, empirical research on the impact of green finance on the sustainable performance of banks within the Yemeni context remains scarce or virtually nonexistent a significant research gap that warrants rigorous investigation to understand the nature of this relationship. How can green finance enhance bank efficiency? Is there a positive relationship between banks' adoption of green financing activities and their financial and environmental sustainability?

1.1 Problem Statement

Yemeni banks confront substantial challenges, including persistent economic crises, political instability, and inadequate infrastructure to support a transition toward a green economy. Under these adverse conditions, it is imperative to reevaluate financing instruments and managerial strategies that can enhance banks' sustainable performance not only financially but also environmentally and socially.

Despite the vital role banks are expected to play as engines of economic development, the Yemeni banking sector remains heavily reliant on traditional financing management approaches, with relatively little attention paid to concepts such as green finance practices that have become essential for achieving sustainable performance in the banking sector.

Although some indications suggest that Yemeni banks are beginning to show interest in sustainability issues, the practical implementation of green finance remains extremely limited nearly absent in many local financial institutions. Recent studies, such as [24], reveal a clear deficiency in institutional capacities required to implement green projects, coupled with a shortage of qualified personnel and specialized knowledge in this field. Moreover, the availability of appropriate financing mechanisms for the green economic transition is crucial for sustainable enterprises. Accordingly, [24]

recommended developing specific financial products for green entrepreneurs and establishing alternative financing mechanisms dedicated to green entrepreneurship.

Other local studies have highlighted the challenges facing Yemen. For instance, [10] demonstrated that the energy sector confronts numerous technical, social, economic, and political challenges including heavy reliance on fossil fuels, outdated infrastructure, persistent electricity outages, and weak implementation of renewable energy projects. Therefore, investment promotion, infrastructure development, and a shift toward green finance are urgently needed.

An analysis by the International Finance Corporation [1], indicated significant progress by various stakeholders in green finance, particularly in incentivization and performance measurement. However, [3] noted that this progress still requires further support and expansion.

[1] further confirmed that Yemeni banks face multiple barriers to adopting green financing policies, including weak infrastructure, lack of modern technology, market volatility, and inadequate supportive legislation. Similarly, [2] pointed out that awareness levels among bank employees and customers regarding green finance concepts remain low, negatively affecting the acceptance and widespread adoption of such initiatives.

Despite international efforts to redirect finance toward environmentally friendly products as noted by [1] progress in this domain remains insufficient, particularly in developing and crisis-affected countries like Yemen. [3] emphasized a clear lack of empirical evidence and practical applications supporting the implementation of green finance within Yemeni banks, despite the availability of general theoretical frameworks.

Numerous studies indicate a positive relationship between banks' adoption of green financing tools and the achievement of sustainable performance whether in terms of financial efficiency, operational effectiveness, or long-term strategic planning capacity [2 – 11].

Thus, this study seeks to analyze these challenges and propose strategic solutions to enhance the sustainable performance of Yemeni banks. Based on the above, the central research question is: What is the role of green finance in enhancing the sustainable performance of Yemeni banks in the Capital City of Sana'a?

This main question is further broken down into the following sub-questions:

1- What is the level of green finance practice among Yemeni banks in the Capital City of Sana'a ?
2- What is the level of sustainable performance among Yemeni banks in the Capital City of Sana'a ?
3- Is there a statistically significant role for green finance in enhancing the sustainable performance of Yemeni banks in the Capital City of Sana'a?

1.2 Study Objectives

This study aims to examine "the role of green finance in enhancing the sustainable performance of Yemeni banks in the Capital City of Sana'a," through the following specific objectives:

1- To identify the level of green finance practice among Yemeni banks in Sana'a .
2- To assess the level of sustainable performance among Yemeni banks in Sana'a .
3- To determine whether green finance plays a statistically significant role in enhancing the sustainable performance of Yemeni banks in Sana'a.

1.3 Significance of the Study

The study derives its significance from the following theoretical and practical contributions:

– Theoretical Significance:

- Enriches the theoretical literature on the relationship between green finance and sustainable performance, particularly within the Arab and Yemeni contexts, which still require in-depth empirical studies.
- Addresses a notable research gap, as it is among the few studies examining this topic within Yemeni banks.

– Practical Significance:

- Represents one of the first studies to address green finance in Yemeni banks a field in urgent need of empirical and theoretical investigation to understand its mechanisms and applications.
- Highlights the importance of green finance as an effective strategy for achieving environmental and financial objectives.
- Supports policymakers in formulating sustainable financing policies.
- Draws attention to successful Arab and global experiences in green finance and explores the feasibility of adapting relevant principles in Yemen.
- Assists decision-makers in Yemeni banks in understanding green finance instruments and how to leverage them to enhance sustainable performance.
- Provides findings and recommendations that can inform the design of training programs for managers and practitioners in the banking sector.
- Contributes to national efforts toward sustainable development by encouraging banks to adopt green financing tools for environmentally friendly projects.
- Enhances societal awareness of the importance of environmental and financial sustainability amid Yemen's economic and political challenges.

1.4 Scope of the Study

The study is delimited as follows:

Thematic Scope: Focuses on the role of green finance through its dimensions (short-term, and medium- to long-term green financing) in enhancing sustainable performance across its dimensions (efficiency and effectiveness, strategic financial planning, and sustainable financial integration) within Yemeni banks in Sana'a.

Geographical Scope: Limited to a group of Yemeni banks in Sana'a that adopt green financing policies, specifically: CAC Bank, Agricultural & Cooperative Lending Bank, Bank of Yemen and Kuwait, Bank of Yemen and the Gulf, Al-Kuraimi Islamic Bank, Al-Kuraimi Islamic Microfinance Bank, and Al-Amal Microfinance Bank.

Human Scope: Includes all senior managers in Yemeni banks in Sana'a who constitute the study population.

Temporal Scope: Conducted during the academic year 2024–2025.

1.5 Operational and Conceptual Definitions

a) Sustainable Performance: Defined conceptually as a bank's ability to utilize its resources efficiently and achieve its objectives effectively, delivering outputs aligned with stakeholder expectations [35].

Operationally: it refers to the level of efficiency and effectiveness achieved by banks in fulfilling their financial, social, and environmental objectives over the long term through strategic financial planning and sustainable financial integration. It is measured via a questionnaire assessing the study's specified dimensions.

- Efficiency and Effectiveness Dimension: Operationally defined as the bank's capacity to optimally utilize available resources to achieve its goals. Measured via questionnaire items evaluating optimal resource use and goal attainment.
- Strategic Financial Planning Dimension: Operationally defined as the bank's practice of formulating long-term financial plans to achieve strategic objectives. Measured via questionnaire items assessing the existence of strategic financial planning mechanisms.
- Sustainable Financial Integration Dimension: Operationally defined as the bank's commitment to providing short- and long-term capital to support sustainable projects. Measured via questionnaire items evaluating the extent of sustainable financial integration.

b) Green Finance: Conceptually defined as "a strategic approach to integrating the financial sector into the transition toward low-pollution, low-carbon, and resource-efficient economies within the context of climate change adaptation" [23].

Operationally: it refers to the provision of short-, medium-, and long-term financial financing to environmentally friendly projects to achieve sustainable economic growth, social equity, and environmental sustainability. It is measured via a questionnaire assessing the study's specified dimensions.

- Short-Term Green Financing: Operationally defined as the provision of financing (less than one year) to green projects. Measured via a questionnaire assessing banks' readiness to provide such funds.
- Medium- and Long-Term Green Financing: Operationally defined as the provision of financing (one to five years or more) to green projects. Measured via a questionnaire assessing banks' readiness to provide such funds.

A bank is defined as "a financial institution that accepts demand and time deposits and engages in domestic and international financing operations, while also promoting savings and domestic and international financial investment and contributing to project development" [9].

1.6 Conceptual Framework

Based on the study's variables (green finance and sustainable performance), the conceptual model is illustrated as follows:

1.6.1 Independent variable: (Green Finance)

Drawing on prior studies [20 ; 2 ; 12 ; 17 ; 11 ; 1 ; 30 ; 39], the following dimensions were selected:

Dimension 1: Short-Term Green Financing.

Rationale: Enables banks to recover funds quickly, enhancing financial support sustainability, profitability, and liquidity.

Dimension 2: Medium- and Long-Term Green Financing.
Rationale: Enhances profitability and risk diversification over multiple years through investment in working capital, fixed assets, or ongoing projects, thereby strengthening financial sustainability.

1.6.2 Dependent variable: (Sustainable Performance)

Based on prior literature [5 ; 8 ; 26], the following dimensions were selected:
Dimension 1: Efficiency and Effectiveness.
Rationale: Enables banks to achieve objectives at minimal cost, time, and effort through optimal resource utilization and high-quality service delivery, ensuring continuity.
Dimension 2: Strategic Financial Planning.
Rationale: Essential for clarifying institutional missions and prioritizing actions necessary to achieve strategic goals.
Dimension 3: Sustainable Financial Integration.
Rationale: Ensures a close linkage between short- and long-term capital sustainability to cover all banking operations and support green financing, thereby guaranteeing financial continuity across current and future generations and achieving long-term financial objectives.
A hypothetical model illustrating the relationships between the study variables and their dimensions, and depicting the impact of green finance on sustainable performance in Yemeni banks, is presented in Figure 1:

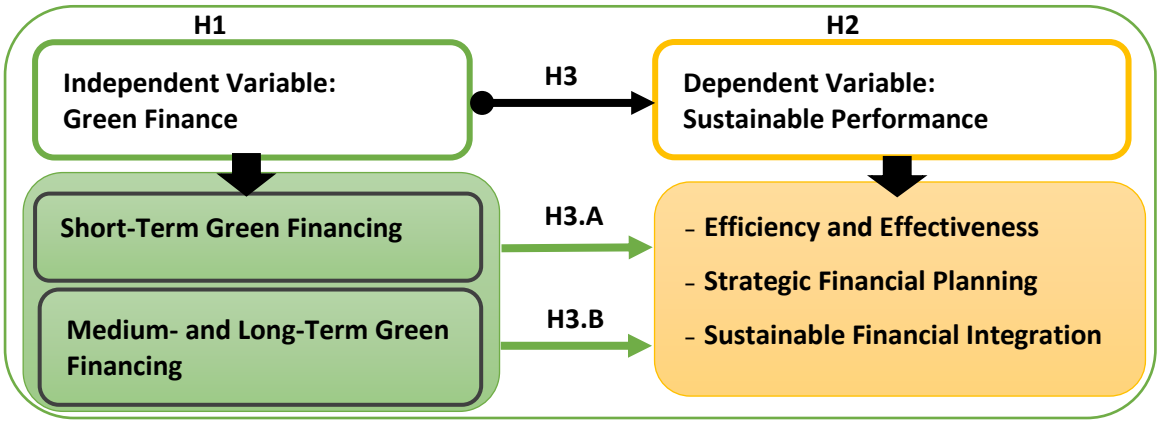

Fig .1. Conceptual Model of the Study

1.7 Theoretical Foundation

– Sustainable Growth Theory [16]:
[16] articulated a foundational theoretical framework for "sustainable growth," emphasizing that economic development cannot be sustainable if it depletes natural resources or disrupts ecological balance. The theory rests on three core pillars:

- Economic Growth: Ensuring continuity of economic activities.
- Social Equity: Achieving intergenerational fairness.
- Environmental Sustainability: Preserving natural capital and respecting ecological regeneration limits.

This theory is widely applied in sustainability studies, particularly in financial and banking sectors transitioning toward green finance and environmental responsibility.

– Scientific Inference in the Context of This Study:

Sustainable Growth Theory applies to Yemeni banks by underscoring the importance of adopting green finance practices aligned with strategic leadership to ensure:

a) Environmentally conscious use of financial resources.
b) Reduction of the carbon footprint of banking and investment operations.
c) Economic growth that does not harm the environment positively reflecting on banks' sustainable performance.

Thus, the theory provides a conceptual foundation supporting the hypothesis that green finance enhances banks' capacity to achieve sustainable performance by adhering to non-environmentally threatening growth principles.

1.8 Review of Previous Studies

a) Study by (35) entitled "The Role of Green Banks in Achieving Environmental Sustainability: A Field Study on a Sample of Iraqi Government Banks – with Reference to the Dutch Experience".

The study aimed to review the role of green banking in achieving environmental sustainability and assess the effectiveness of green banking products and services. It adopted a descriptive-analytical approach and purposively selected two Iraqi government banks (Rafidain and Rasheed). A questionnaire was distributed to 50 customers. The Dutch experience was referenced as a leading model in environmentally friendly banking services. The study concluded that Iraqi banks possess substantial financial and human resources that, if properly utilized, could significantly contribute to environmental protection.

b) Study by (17) entitled "The Role of Green Finance in Enhancing the Environmental Dimension of Sustainable Development: A Study of Experiences in the UAE, China, and Algeria".

The study aimed to explore the concept of green finance within sustainable development, identify optimal pathways for leveraging green finance to achieve SDGs in Algeria, and examine financing mechanisms such as green bonds, green banks, and environmental taxation. It employed inductive and deductive methods and relied on desk research. The study concluded that green taxation is particularly suitable for developing countries due to its lower dependency on advanced green financial markets or high public awareness.

c) Study by (12) entitled "The Role of Green Finance in Supporting Environmentally Friendly Projects through the Issuance of Green Bonds: Evaluation and Analysis of Models from the International Finance Corporation".

The study aimed to evaluate and analyze the reality of the green finance market and green bond issuances, assess the reality and volume of green bond issuances by the International Finance Corporation, and focus on evaluating and analyzing the contribution of the International Finance Corporation's issuances and the most important models it has adopted in supporting the environmental dimension. The study relied on the descriptive analytical approach and used the desk research method of literature as a tool for data collection and document analysis as a study tool by reviewing literature and previous studies as a sample for the study. The study concluded that green bonds, according to several reports, will play a major role in financing economies that rely on renewable energy or commit to reducing carbon emissions, and that developing these tools requires activating the role of capital markets by developing funds concerned with sustainability and green

and social bonds, and increasing issuances by actors such as the effective contribution of the International Finance Corporation in supporting this trend by financing pioneering environmentally friendly projects in many countries around the world.

d) Study by (21) entitled "The Role of Green Finance in Achieving Financial Sustainability: An Analytical Study of the Opinions of a Sample of Employees in Jehan and Al-Mosul Banks for Development and Investment in Nineveh Governorate".

The study aimed to highlight green finance and its role in achieving financial sustainability. The study used the descriptive, analytical, and inductive approach. The study population consisted of (Al-Mosul Bank for Development and Investment and Jehan Islamic Bank), and its sample included (45) respondents from among its employees, relying on the questionnaire as the main tool for data collection. The study concluded with several results, the most important of which is that green finance has an important role in achieving financial sustainability, and there are significant correlation and influence relationships between green finance and its dimensions and achieving financial sustainability.

e) Study by (1) entitled "Green Finance and its Role in Improving the Performance of Green Banks: An Exploratory Study of the Opinions of a Sample of Bank Managers".

The study aimed to measure and analyze the extent to which banks adopt green finance strategies and to demonstrate the impact of green finance in improving the performance of green banks as one of the modern approaches in banking. To achieve the research objective, the study adopted the descriptive analytical approach. A random sample of five Iraqi banks was selected, and a questionnaire was prepared and formulated through reviewing previous studies and validated by a number of specialized professors. The questionnaire was distributed to the senior management in the banks of the research sample, with (10) questionnaires for each bank. The study concluded that there is no clear understanding of the concept of green finance and green banks as it is a new concept.

1.9 Critical Review of Previous Literature

1.9.1 *Similarities and Differences with Previous Studies*

Topic and Context: This study differs by focusing specifically on the link between green finance and sustainable performance in Yemeni banks in Sana’a unlike prior studies conducted in Iraq, Algeria, Egypt, Kenya, or Nigeria .

While most prior studies used descriptive-analytical methods (similar to this study), [17] and [12] relied solely on desk research .

Sampling: This study employed stratified random sampling (n=236 managers from 6 banks), whereas others used purposive sampling .

Instrument: All studies used questionnaires except [17], which used document analysis.

1.9.2 Benefits Drawn from Previous Studies

- Enriched theoretical framework .
- Leveraged references and validated measurement scales .
- Adopted robust methodological and statistical approaches.

1.9.3 Distinctive Features of This Study

- Among the first local studies to address green finance in Yemeni banks .
- Focuses explicitly on the causal relationship between green finance and sustainable performance.

1.9.4 Research Gap

- No prior studies directly link green finance to sustainable banking performance in Yemen .
- Lack of empirical, field-based, quantitative research in this context .
- Absence of policy-oriented analysis aligned with SDGs in Yemen's fragile setting.

2. Research Methodology and Procedures

2.1 Research Methodology

The study adopted a descriptive-analytical approach, suitable for describing the current state of green finance and sustainable performance and analyzing the relationship between variables using SPSS for hypothesis testing.

2.2 Study Population

The population comprised employees from (17) banks in Sana'a (13). The study focused on 6 banks implementing green finance policies "Which employ green financing policies in managing their funds from the total of (17) banks, and this was confirmed through field visits to all banks and inquiry into their implementation of green financing policies or not", with a total population of (789) individuals, as detailed in Table 1.

Table 1
Study Population Across Six Yemeni Banks

Bank Type	Bank Name	Establishment Year	Number of Employees
Government Bank	**Agricultural & Cooperative Lending Bank**	**1982**	**250**
Commercial Bank	**Bank of Yemen and Kuwait**	**1979**	**84**
Commercial Bank	**Bank of Yemen and the Gulf**	**1982**	**50**
Islamic Bank	**Al-Kuraimi Islamic Bank**	**2020**	**35**
Microfinance Bank	**Al-Kuraimi Islamic Microfinance Bank**	**2010**	**220**
Microfinance Bank	**Al-Amal Microfinance Bank**	**2010**	**150**
Total			**789**

Source: Human Resources Departments of Yemeni Banks, Sana'a, 2023.

2.3 Study Sample

Based on [40] table, a sample size of (260) was determined for a population of (789). Stratified random sampling was used. Table 2 shows the distribution.

Table 2
Study Sample Distribution

Bank Name	Chad	GM	Deputy	Assistant	Total	Percentage
Agricultural & Cooperative Lending Bank	**3**	**2**	**23**	**25**	**42**	**95**	**36%**
Bank of Yemen and Kuwait		**1**	**2**	**10**	**17**	**30**	**12%**
Bank of Yemen and the Gulf	**1**		**2**	**5**	**12**	**20**	**8%**
Al-Kuraimi Islamic Bank			**2**	**7**	**11**	**20**	**8%**
Al-Kuraimi Islamic Microfinance Bank	**2**	**3**	**5**	**13**	**27**	**50**	**19%**
Al-Amal Microfinance Bank	**1**		**5**	**9**	**30**	**45**	**17%**
Total	**7**	**6**	**39**	**69**	**139**	**260**	**100%**

Source: Researcher's compilation

Of the (260) distributed questionnaires, (255) were returned. After excluding (19) invalid responses, (236) valid questionnaires remained (91%) response rate, as shown in Table (2-3).

Questionnaire Response and Validity Summary:

Table 3
Valid Questionnaires for Statistical Analysis

Distributed	Returned	Lost	Excluded (Invalid)	Valid	Valid %
260	**255**	**5**	**19**	**236**	**91%**

2.4 Data Collection Sources

Secondary Sources: Official reports, books, journals, prior studies, and internet resources for theoretical grounding.
Primary Sources: Questionnaire for empirical data collection and hypothesis testing.

2.5 Study Instrument

A structured questionnaire was developed based on literature review and prior studies. It consisted through the following steps:

a) Demographic Variables: Gender, age, academic specialization, qualification, job title, years of experience.

b) Study Variables: (29) items across two variables:

- Independent Variable (Green Finance):
  - Short-term green financing (5) items.
  - Medium- and long-term green financing (5) items.
- Dependent Variable (Sustainable Performance):
  - Efficiency and effectiveness (9) items.
  - Strategic financial planning (5) items.
  - Sustainable financial integration (5) items.

c) point Likert scale was used (1 = Strongly Disagree to 7 = Strongly Agree), as shown in Table 4:

Table 4
7-Point Likert Scale

Response	Strongly Agree	Agree	Somewhat Agree	Neutral	Somewhat Disagree	Disagree	Strongly Disagree
Score	7	6	5	4	3	2	1

This scale allowed respondents to express their opinions with greater precision, enhancing the reliability and validity of the collected data.

d) Interpretation Criterion Item:

Responses to each item were interpreted based on the assigned Likert value, ranging from (1) (Strongly Disagree) to (7) (Strongly Agree). Higher scores indicated stronger agreement with the statement, reflecting more positive perceptions of green financing practices or sustainable performance.

e) Validity- Face Validity Content:

To ensure content validity, the initial draft of the questionnaire was reviewed by the researcher's academic supervisor, who provided feedback for refinement. Subsequently, the instrument was submitted to a panel of (14) academic experts from university faculty members specializing in finance, banking, and sustainability. Their comments were incorporated to enhance clarity, relevance, and theoretical alignment.

f) Instrument Administration:

Following validation, the finalized questionnaire was distributed to the target sample of (260) respondents. A total of (236) valid responses were obtained, representing a (91%) effective response rate, which is considered high and suitable for robust statistical analysis.

2.6 Validity and Reliability Testing

2.6.1 Content Validity (Face Validity)

The questionnaire was reviewed by the thesis supervisor and (14) academic experts from Yemeni universities.

2.6.2 Internal Consistency Validity

Pearson correlation coefficients were computed between each item and its respective dimension and total score. Results are shown in Tables 5 and 6:

2.6.2.1 Internal Consistency of the Independent Variable for Green Finance

Table 5
Pearson Correlation for Green Finance Items

Item	Item Correlation Coefficient		Item	Item Correlation Coefficient	
	With Total Dimension	Overall Axes		With Total Dimension	Overall Axes
First Dimension: Short-Term Green Finance			Second Dimension: Medium/Long-Term Green Finance		
1	.863**	.906**	1	.800**	.901**
2	.917**		2	.763**	
3	.916**		3	.816**	
4	.874**		4	.752**	
5	.844**		5	.526**	

As shown in Table 5:

– All correlations significant at ($p < 0.05$).
– Short-term dimension: item-total correlations ranged from 0.863 to 0.844; total variable correlation = 0.906.
– Medium/long-term dimension: item-total correlations ranged from 0.800 to 0.526; total variable correlation = 0.901.

These results confirm that all items are conceptually aligned with their intended constructs and are valid for measuring green financing.

2.6.2.2 Internal Consistency of the Independent Variable for Sustainable Performance

Table 6
Pearson Correlation for Sustainable Performance Items

Item	Item Correlation Coefficient		Item	Item Correlation Coefficient	
	With Total Dimension	Overall Axes		With Total Dimension	Overall Axes
First Dimension: Efficiency & effectiveness			**Second Dimension: Strategic financial planning**		
1	.769**	.917**	1	.895**	.949**
2	.833**		2	.919**	
3	.888**		3	.915**	
4	.897**		4	.924**	
5	.891**		5	.898**	
6	.901**		**Third Dimension: Sustainable financial integration**		
7	.894**		1	.872**	.943**
8	.893**		2	.906**	
9	.847**		3	.923**	
			4	.930**	
			5	.917**	

As shown in Table 6:
– All correlations significant at ($p < 0.05$):
– Efficiency & effectiveness: item-total correlations 0.769–0.847; total correlation = 0.917.
– Strategic financial planning: 0.895–0.898; total = 0.949.
– Sustainable financial integration: 0.872–0.917; total = 0.943.

All correlations were statistically significant, confirming that each item belongs to its designated dimension and is valid for measuring sustainable performance.

2.6.3 Reliability (Cronbach's Alpha)

Reliability was assessed using Cronbach's Alpha coefficient following a pilot test. The results are presented in Table 7. and show high reliability across all dimensions.

Table 7
Cronbach's Alpha Coefficients

Variable / Dimension	No. of Items	Cronbach's Alpha
Green Finance (Total)	**10**	**0.89**
– Short-Term	**5**	**0.93**
– Medium/Long-Term	**5**	**0.74**
Sustainable Performance (Total)	**19**	**0.98**
– Efficiency & Effectiveness	**9**	**0.96**
– Strategic Financial Planning	**5**	**0.95**
– Sustainable Financial Integration	**5**	**0.95**

All values exceed the acceptable threshold ($\alpha \geq 0.70$), confirming instrument reliability. As shown in Table 7, all Cronbach's Alpha values ranged between (0.74 and 0.96), which are well above the commonly accepted threshold of (0.70) (Nunnally, 1978). This indicates high internal consistency and confirms the reliability of the questionnaire across all constructs and sub-dimensions.

2.7 Statistical Methods

Data were analyzed using (SPSS v27) with the following techniques:

– Pearson correlation for construct validity.
– Cronbach's alpha for reliability.
– Frequencies and percentages for demographic description.
– Mean and standard deviation for variable assessment.
– Simple and multiple regression for hypothesis testing.
– Independent-samples t-test for gender differences.
– One-way ANOVA for differences across age, qualification, job title, and experience.

2.8 Demographic Profile of the Sample

To analyze the demographic variables of the study participants and assess the representativeness of the sample responses, descriptive statistics were computed for all personal attributes. The results are summarized in Table 8 below.

Key Observations:

– Majority male (72%), reflecting Yemeni banking sector demographics.
– Most respondents aged 36–40 (32.6%), indicating experienced, dynamic leadership.
– Accounting is the dominant specialization (32.2%).
– (%75) hold bachelor's degrees or higher, ensuring informed responses.
– (%56.4) are section heads key implementers of banking policies.
– (%41.9) have 16+ years of experience, enhancing response reliability.

Overall, the demographic profile reflects a sample of experienced, highly educated banking professionals, predominantly in mid-to-senior operational roles. This composition supports the robustness and contextual relevance of the empirical findings.

Table 8
Demographic Characteristics of the Sample (n=236)

Variable	Category	Frequency	Percentage
Gender	**Male**	**170**	**72%**
	Female	**66**	**28%**
Age	**25–30**	**31**	**13.1%**
	31–35	**40**	**16.9%**
	36–40	**77**	**32.6%**
	41–45	**47**	**19.9%**
	≥46	**41**	**17.4%**
Specialization	**Accounting**	**76**	**32.2%**
	Other	**62**	**26.3%**
	Business Admin	**45**	**19.1%**
	Banking & Finance	**39**	**16.5%**
	Economics	**14**	**5.9%**
Qualification	**Bachelor's**	**177**	**75.0%**
	Master's	**31**	**13.1%**
	PhD	**17**	**7.2%**
	Diploma	**8**	**3.4%**
	Secondary	**3**	**1.3%**
Job Title	**Section Head**	**133**	**56.4%**
	Dept. Manager	**53**	**22.5%**
	GM/Deputy	**37**	**15.7%**
	Chairman/Deputy	**7**	**3.0%**
	Advisor	**6**	**2.5%**
Years of Experience	**≥16**	**99**	**41.9%**
	11–15	**74**	**31.4%**
	6–10	**35**	**14.8%**
	≤5	**28**	**11.9%**

3. Results and Discussion

3.1 Answer to Research Question 1: Level of Green Finance Practice

3.1.1 Overall Green Finance Practice

To address the first research sub-question "What is the level of green financing practices in Yemeni banks in Sana'a City?" descriptive statistics (mean, standard deviation, and percentage agreement) were computed for the overall green financing construct, its two dimensions, and individual items. The results are presented in Table 9.

Table 9
Statistical Analysis of Green Finance Practice

n	Dimension	Rank	Mean	SD	Agreement %	Interpretation
1.	**Short-Term Green Finance**	**1**	**5.66**	**0.975**	**81%**	**High**
2.	**Medium/Long-Term Green Finance**	**2**	**5.29**	**0.950**	**71%**	**Moderately High**
Green Finance (Total)			**5.48**	**0.869**	**78%**	**High**

As shown in Table 9:

- Overall green finance practice is high (78% agreement, Mean = 5.48).
- Short-term financing ranks highest (81%), reflecting banks' preference for quick-return, liquid green projects.

– Medium/long-term financing is moderately high (71%) but shows greater divergence (SD = 0.950), indicating inconsistent implementation.

Interpretation and Discussion:

The results showed that:

- The standard deviation (0.869) is relatively low overall, indicating agreement among the sample's opinions on this variable.
- The second dimension (medium and long-term green finance) recorded a higher deviation (0.950), indicating a difference in views on this dimension.
- The high level of green finance in general reflects the increasing desire of Yemeni banks to adopt sustainable banking practices.
- The focus on short-term green finance (paragraph 1 with 5.66) shows that banks recognize the importance of financing projects that achieve quick returns.
- The low level of medium and long-term green finance (average 5.29) indicates weak investment in long-term projects.

Interpretation: These results can be interpreted as Yemeni banks preferring short-term financing to improve liquidity and enhance profitability in unstable conditions. The weak investment in long-term projects may be due to financial, environmental, and cultural constraints.

Banks prioritize short-term green loans due to economic instability, seeking rapid returns and liquidity. However, limited long-term investment hinders true sustainability. This aligns with [1] but contrasts with [32], likely due to Yemen's unstable context versus Egypt's relative stability.

These findings align with [32], who reported that banks prioritize green financing for renewable energy projects across short, medium, and long maturities at favorable rates. However, the current study reveals a clear preference for short-term instruments, likely driven by Yemen's unstable economic and political context (e.g., war, hyperinflation, currency volatility). Short-term green loans offer quicker returns and enhanced liquidity critical advantages in crisis environments.

Conversely, the moderately high rating for medium- and long-term green financing suggests structural and operational constraints, including:

– Financial limitations: capital scarcity and market instability

– Environmental barriers: inadequate infrastructure for green projects (e.g., solar energy).

– Cultural resistance: low awareness among clients and investors about green finance benefits

While short-term focus supports immediate liquidity, underinvestment in long-term green projects may undermine sustainable development. Without strategic, long-horizon commitments, banks risk perpetuating short-termism that fails to address systemic environmental and financial challenges.

3.1.2 Detailed Analysis of Green Finance Dimensions

3.1.2.1 Short-Term Green Finance Items

As shown in Table 10:

– Highest agreement on bank prioritization (5.76).

– Lowest on beneficiary preference (5.54), suggesting limited customer awareness or demand.

Interpretation and Discussion:

The relatively low SD (0.975) confirms strong consensus, except for Item 4 (SD = 1.131), reflecting uncertainty about client behavior.

These results support [1] but contrast with [32], where client preference ranked higher again highlighting contextual differences between stable and conflict-affected economies.

Table 10
Short-Term Green Finance Items

n	Item	Rank	Mean	SD	%	Interpretation
1.	**Bank prioritizes short-term green financing**	**1**	**5.76**	**1.081**	**82%**	**High**
2.	**The bank sets priorities for short-term loans to green projects**	**4**	**5.65**	**1.079**	**81%**	**High**
3.	**Short-term green loans achieve good profitability**	**3**	**5.66**	**1.082**	**81%**	**High**
4.	**Beneficiaries prefer short-term green loans**	**5**	**5.54**	**1.131**	**79%**	**High**
5.	**Short-term financing carries lower risk**	**2**	**5.69**	**1.153**	**81%**	**High**
Dimension Mean			**5.66**	**0.975**	**81%**	**High**

3.1.2.2 Medium/Long-Term Green Finance Items

Table 11
Medium/Long-Term Green Finance Items

n	Item	Rank	Mean	SD	%	Interpretation
1.	**The bank provides medium- and long-term financing for green projects.**	**3**	**5.51**	**1.169**	**79%**	**High**
2.	**The bank allows conversion of conventional loans into green loans.**	**4**	**5.27**	**1.306**	**75%**	**Moderately High**
3.	**The bank finances green infrastructure projects.**	**2**	**5.53**	**1.215**	**79%**	**High**
4.	**Bank seeks to achieve SDGs.**	**1**	**5.73**	**1.156**	**82%**	**High**
5.	**Central Bank directs banks to fund green projects.**	**5**	**4.41**	**1.821**	**63%**	**Moderately High**
Dimension Mean			**5.29**	**0.950**	**76%**	**Moderately High**

As shown in Table 11:

– Strong commitment to SDGs (5.73).

– Weak perceived role of Central Bank (4.41, SD = 1.821), indicating regulatory gaps.

Interpretation and Discussion:

The researcher attributes the moderate engagement in long-term green finance to high macroeconomic risk (inflation, currency collapse) and infrastructure deficits. Nevertheless, the strong SDG commitment suggests banks recognize green finance as a strategic imperative for national recovery.

This aligns with [1] but contrasts with [21], where regulatory support ranked highly underscoring Yemen's institutional constraints.

The findings also support the Environmental Adaptation Theory: firms in unstable environments favor low-risk, short-return investments. However, the emphasis on SDGs signals an emerging shift toward long-term resilience.

3.2 Answer to Research Question 2: Level of Sustainable Performance

3.2.1 Overall Sustainable Performance

To address the second research sub-question "What is the level of sustainable performance in Yemeni banks in Sana'a City?" descriptive statistics (mean, standard deviation, and percentage

agreement) were computed for the overall sustainable performance construct, its three dimensions, and individual items. The results are presented in Table 12.

Table 12
Sustainable Performance Dimensions

n	Dimension	Rank	Mean	SD	%	Interpretation
1.	**Efficiency and Effectiveness**	**2**	**4.91**	**1.330**	**70%**	**Moderately High**
2.	**Strategic Financial Planning**	**1**	**4.94**	**1.419**	**71%**	**Moderately High**
3.	**Sustainable Financial Integration**	**3**	**4.73**	**1.490**	**68%**	**Moderately High**
Total Sustainable Performance			**4.86**	**1.324**	**69%**	**Moderately High**

As shown in Table 12:

- Overall performance is moderately high (69%).
- Strategic Financial planning for first .
- Financial integration is weakest (68%, SD = 1.490), reflecting poor coordination between short- and long-term financing.

Interpretation and Discussion:

Banks recognize strategic planning and operational efficiency but struggle with integrated, long-term financial sustainability due to instability and weak infrastructure.

These findings suggest that Yemeni banks are making measured efforts toward sustainable performance but face significant structural and environmental constraints. The moderately high scores reflect institutional awareness of sustainability principles, yet implementation remains inconsistent likely due to Yemen's protracted conflict, economic instability, and weak regulatory infrastructure.

The emphasis on strategic financial planning aligns with [21], who identified long-term financial strategy as a cornerstone of sustainability. However, the inability to translate planning into integrated action evident in the lower score for financial integration reveals a gap between intention and execution.

This result also supports the Integrated Sustainability Theory, which posits that true sustainability requires balanced integration of financial, environmental, and social dimensions. The current data indicate that while banks recognize the importance of strategic planning, they struggle to operationalize it across time horizons and functional units.

The findings contrast with [5], which reported high efficiency and strong financial integration in stable contexts. The discrepancy underscores how institutional fragility in conflict-affected settings like Yemen impedes the translation of sustainability rhetoric into practice.

3.2.2 Detailed Analysis of Sustainable Performance Dimensions

3.2.2.1 Efficiency and Effectiveness Items

Table 13
Efficiency and Effectiveness Items

N	Item	Rank	Mean	SD	%	Interpretation
1.	**Bank leadership invests in individual skills to improve performance**	**6**	**4.92**	**1.498**	**70%**	**Moderately High**
2.	**The bank exhibits strong integration among departments and units**	**7**	**4.82**	**1.724**	**69%**	**Moderately High**
3.	**The bank encourages optimal use of working time**	**2**	**5.02**	**1.428**	**72%**	**Moderately High**
4.	**Bank continuously evaluates employees**	**1**	**5.06**	**1.502**	**72%**	**Moderately High**
5.	**There is a good relationship between bank leadership and staff**	**3**	**4.97**	**1.486**	**71%**	**Moderately High**
6.	**Bank operations are sufficiently flexible to achieve objectives**	**5**	**4.93**	**1.476**	**70%**	**Moderately High**
7.	**The bank continuously develops new training programs**	**4**	**4.94**	**1.467**	**71%**	**Moderately High**
8.	**Leadership addresses problems hindering goals**	**9**	**4.77**	**1.560**	**68%**	**Moderately High**
9.	**Bank leadership updates service procedures in response to market changes**	**8**	**4.80**	**1.665**	**69%**	**Moderately High**
Dimension Mean			**4.91**	**1.330**	**70%**	**Moderately High**

As shown in Table 13:

– Highest: “Bank continuously evaluates employees” (Mean = 5.06, 72%).

– Lowest: “Leadership addresses problems hindering goals” (Mean = 4.77, 68%).

Interpretation and Discussion:

These results support the Continuous Improvement Theory, which emphasizes ongoing evaluation and adaptation. However, the gap between evaluation (high) and problem resolution (low) reveals a bottleneck in implementation possibly due to limited authority, resources, or technical capacity.

3.2.2.2 Strategic Financial Planning Items

Table 14

Strategic Financial Planning Items

n	Item	Rank	Mean	SD	%	Interpretation
1.	**Bank leadership prioritizes long-term financial planning.**	**3**	**4.95**	**1.535**	**71%**	**Moderately High**
2.	**The bank sets priorities for financial actions to achieve its goals.**	**2**	**5.03**	**1.482**	**72%**	**Moderately High**
3.	**Bank seeks new resources for future expansion**	**1**	**5.04**	**1.556**	**72%**	**Moderately High**
4.	**The bank adopts modern financing policies**	**4**	**4.92**	**1.616**	**70%**	**Moderately High**
5.	**Bank flexibly redirects plans amid crises**	**5**	**4.77**	**1.611**	**68%**	**Moderately High**
Dimension Mean			**4.94**	**1.419**	**71%**	**Moderately High**

As shown in Table 14:

– Highest: “Bank seeks new resources for future expansion” (Mean = 5.04, 72%).

– Lowest: “Bank flexibly redirects plans amid crises” (Mean = 4.77, 68%).

Interpretation and Discussion:

This pattern suggests that while banks aspire to strategic planning, they lack the agility to adjust in real time a critical gap in volatile contexts.

3.2.2.3 Sustainable Financial Integration Items

Table 15
Sustainable Financial Integration Items

n	Item	Rank	Mean	SD	%	Interpretation
1.	**Bank maintains mix of short- and long-term capital**	**5**	**4.68**	**1.618**	**67%**	**Moderately High**
2.	**The bank achieves financial integration to cover operational costs**	**3**	**4.74**	**1.636**	**68%**	**Moderately High**
3.	**The bank supports modern financing operations.**	**2**	**4.76**	**1.553**	**68%**	**Moderately High**
4.	**Bank provides sustainable financial services**	**1**	**4.76**	**1.677**	**68%**	**Moderately High**
5.	**Integration of short- and long-term capital ensures financial/environmental.**	**4**	**4.71**	**1.705**	**67%**	**Moderately High**
Dimension Mean			**4.73**	**1.490**	**68%**	**Moderately High**

As shown in Table 15:

– Highest: “Bank provides sustainable financial services” (Mean = 4.76, 68%).

– Lowest: “Bank maintains mix of short- and long-term capital” (Mean = 4.68, 67%).

Interpretation and Discussion:

The researcher notes that while banks claim to offer sustainable services, the weak capital integration suggests these may be symbolic rather than substantive. True financial integration requires stable policy, infrastructure, and market demand all of which are compromised in Yemen. This supports the Financial Integration Theory, but also highlights its contextual limitations in fragile states.

3.3 Answer to Research Question 3: Relationship Between Green Finance and Sustainable Performance

To address the third research question “Is there a statistically significant role of green financing in enhancing sustainable performance in Yemeni banks in Sana’a City?” multiple linear regression analysis was employed. The results are presented in Table 17.

Table 16
Regression Results – Overall Relationship

R	R^2	F	Sig.	β	t	Sig.
.049a	**0.002**	**0.558**	**.456b**	**0.049**	**0.747**	**0.456**

As shown in Table 16:

– Statistically significant positive relationship (p = 0.456).

– Green finance explains (0.2%) of variance in sustainable performance.

– Furthermore, the impact coefficient value (β) of (0.049) explains that these standardized coefficients indicate changes in standard deviations, meaning that assuming the control of any other variables not included in the study, a (100%) increase in commitment to green financing practices will lead to a (4.9%) increase in sustainable performance enhancement.

Interpretation and Discussion:

The low R^2 (0.2%) reflects the overwhelming influence of external factors (war, inflation, infrastructure gaps) in Yemen's fragile context.

These findings align with Integrated Sustainability Theory, which posits that environmental and financial strategies must be aligned to achieve long-term organizational resilience. However, the limited explanatory power (R^2 = 0,2%) underscores a critical insight: in fragile and conflict-affected states like Yemen, internal managerial practices (e.g., green financing) are constrained by overwhelming external forces.

The coefficient of determination (R^2) indicates that green financing, in general, explains (0.2%) of the variance (variations) in enhancing sustainable performance, suggesting that (0.2%) of sustainable performance enhancement results from the practice of green financing. This low percentage may be attributed to the influence of other unexamined external factors, such as: high inflation or currency instability, the absence of infrastructure to support renewable energy projects, and the shortage of qualified personnel or resistance to change. Additionally, in unstable environments, external factors such as government policies or warfare play a more significant role in determining performance compared to green financing. Yemeni banks lack the necessary resources to finance green projects or develop infrastructure, and employees or leaders resist the concept of green financing due to insufficient training and focus on immediate issues rather than long-term planning.

Nevertheless, the positive and significant β coefficient confirms that green financing remains a valuable lever for enhancing sustainability even in adverse contexts. It serves as a signal of institutional commitment, builds stakeholder trust, and lays the groundwork for future resilience.

This result is consistent with [21], who found a significant positive relationship between green financing and sustainable performance. However, it contrasts with [35], which reported R^2 = 0.25 in stable economies (e.g., Egypt). The stark difference highlights how institutional fragility in Yemen dilutes the effectiveness of sustainability initiatives.

Sub-Analysis: Differential Impact of Green Financing Time Horizons:

To further unpack the relationship, two sub-questions were tested using multiple regression:
Sub-question: "Does short-term green financing significantly enhance sustainable performance?"
Sub-question: " Does medium- and long-term green financing significantly enhance sustainable performance?"
Results are presented in Table 17.

Table 17
Regression Results – Sub-dimensions

Dimension	β	SE	Beta	t	Sig.
Short-Term Green Finance	**-0.225**	**0.113**	**-0.165**	**-1.987**	**0.048**
Medium/Long-Term Green Finance	**0.307**	**0.116**	**0.221**	**2.649**	**0.009**

As shown in Table 17:

- Short-term financing: No significant effect (β = -0.225, p = 0.048).
- Medium/long-term financing: Strong positive effect (β = 0.307, p = 0.009). A 100% increase leads to a (30.7%) improvement in sustainable performance.

Interpretation and Discussion:

Yemeni banks should shift focus from short-term green lending toward medium- and long-term green infrastructure projects.

The Central Bank and policymakers must establish enabling frameworks: green credit - guarantees, interest rate subsidies, and SDG-aligned reporting standards. Banks should enhance - client education to build demand for long-term green financial products.

This nuanced finding reveals a critical insight: not all forms of green financing contribute equally to sustainability. In Yemen's volatile context, longer-term green investments despite being less prevalent are far more impactful than short-term instruments, which show no meaningful contribution and even exhibit a negligible negative association.

However, the low explanatory power (R^2 = 0.2%) indicates that while the relationship is significant, green financing alone accounts for only a small portion of the variance in sustainable performance. This underscores the dominant role of contextual and external factors such as macroeconomic instability, institutional fragility, and infrastructural deficits in shaping bank performance in Yemen's conflict-affected environment.

Theoretical Interpretation:

- **Environmental Adaptation Theory:** In unstable environments, short-term investments fail to ensure sustainability.
- **Resource-Based View:** Yemeni banks lack the technology and expertise to convert short-term green finance into sustainable outcomes.
- **Risk-Investment Theory:** High uncertainty (inflation, power outages) makes short-term green projects risky and unattractive.

4. Key Findings, Conclusions, and Recommendations

4.1 Key Findings

– Green finance practice is high (78%), dominated by short-term financing (81%).
– Sustainable performance is moderately high (69%), weakest in financial integration (68%).
– Green finance has a statistically significant but modest impact on sustainable performance (R^2 = 0.2%).
– Only medium/long-term green financing significantly enhances sustainable performance (β = 0.307).

*4.2 **Conclusions***

– Yemeni banks show willingness to adopt green finance but remain risk-averse, favoring short-term liquidity over long-term sustainability.
– Sustainable performance is constrained by external instability and internal gaps in financial integration.
– True sustainability requires shifting focus from short-term to medium/long-term green investments aligned with SDGs.

4.3 ***Recommendations***

- Based on empirical evidence demonstrating the limited impact of traditional green financing in explaining variance in sustainable performance (0.2%) and the low return on investment from increased commitment (4.9%), it is recommended to implement a comprehensive strategic approach that combines developing a unified regulatory framework for medium and long-term green investments (5-15 years) including graded risk assessment criteria and graduated regulatory incentives for banks, restructuring investment portfolios to allocate (70-80%) of the green portfolio to long-term investments in renewable energy projects and sustainable infrastructure with developing innovative risk assessment models that integrate environmental and social criteria with traditional financial indicators, establishing internal funds dedicated to long-term green investments with maturity periods exceeding seven years, through periodic implementation and monitoring mechanisms that measure the effectiveness of the transition from short-term financing to strategic long-term investments, in order to achieve a qualitative transformation in green financing strategy from focusing on short-term financial products toward strategic investments contributing to genuine sustainable development and stable long-term returns.
- Raise awareness among customers and investors about green finance benefits through campaigns.
- Incentivize medium/long-term green lending (e.g., interest subsidies, extended repayment).
- Strengthen regulatory frameworks: Central Bank should issue binding green finance guidelines.
- Develop green infrastructure via public-private-international partnerships.
- Integrate sustainability into governance: Create dedicated units and digital monitoring systems.
- Link sustainable performance to staff incentives via clear KPIs.
- Provide specialized training on green project evaluation and SDG alignment.
- Establish green investment funds for renewable energy, water, and post-war rehabilitation.
- Adopt national green finance policies aligned with SDGs.
- Encourage banks to develop internal green action plans focused on solar energy, recycling, and green agriculture.

5. Conclusions

This study confirms that green finance plays a statistically significant role in enhancing the sustainable performance of Yemeni banks in Sana'a, particularly through medium- and long-term financing instruments. While overall green finance practices are rated as high (78% agreement), they remain heavily skewed toward short-term instruments due to economic instability and risk aversion. Sustainable performance is moderately high (69%), yet constrained by weak financial integration and external contextual challenges. Crucially, only medium- and long-term green financing demonstrates a substantial positive impact ($\beta = 0.307$, $p = 0.009$), whereas short-term financing shows no significant effect. These findings underscore the need for Yemeni banks to shift from liquidity-driven short-term green lending toward strategic, long-horizon investments aligned with the Sustainable Development Goals (SDGs). Given Yemen's fragile context, institutional and regulatory support is essential to amplify the impact of green finance on sustainability outcomes. Given the highly volatile and unpredictable socioeconomic landscape of conflict-torn environments, traditional linear empirical models may not fully capture the non-linear, qualitative disruptions affecting banking institutions.

Future research should leverage advanced Multi-Criteria Decision-Making frameworks integrated with Fuzzy Set theory [40-47]. Utilizing fuzzy logic would allow researchers to model the vague, hesitant, and highly uncertain expert judgments of banking executives under conditions of macroeconomic shocks. By shifting from crisp statistical regressions to adaptive fuzzy MCDM algorithms, subsequent studies can better weigh the competing pressures of active warfare, hyperinflation, and environmental initiatives, providing a more resilient, dynamic decision-support framework for sustainable banking in fragile states.

Author Contributions

Conceptualization, H.S.S.A. Al-Khawlani and N.M.A. Al-Olofi; methodology, H.S.S.A. Al-Khawlani; software, H.S.S.A. Al-Khawlani; validation, H.S.S.A. Al-Khawlani and N.M.A. Al-Olofi; formal analysis, H.S.S.A. Al-Khawlani; investigation, H.S.S.A. Al-Khawlani; resources, H.S.S.A. Al-Khawlani; data curation, H.S.S.A. Al-Khawlani; writing original draft preparation, H.S.S.A. Al-Khawlani; writing review and editing, H.S.S.A. Al-Khawlani and N.M.A. Al-Olofi; visualization, H.S.S.A. Al-Khawlani; supervision, N.M.A. Al-Olofi; project administration, H.S.S.A. Al-Khawlani. All authors have read and agreed to the published version of the manuscript.

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