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Research paper

The Interplay between Fintech and Green Finance in Saudi Arabia: The Moderating Role of Education and Experience

Heba Gazzaz *, Roaa Badkook

Finance Department, Faculty of Administrative and Economic, King Abdulaziz University, Jeddah, Saudi Arabia
**Corresponding author E-mail: hagazzaz@kau.edu.sa*

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Abstract

The adoption of innovative technologies in the financial sector enables firms to enhance their sustainability performance. This study focuses on examining the relationship between FinTech adoption and green initiatives of financial institutions in Saudi Arabia. It also investigates the moderating effects of education and experience of the respondents in the relationship between FinTech and green activities. Data was collected via a questionnaire survey from 304 individuals working in financial institutions in Saudi Arabia. The Pearson correlation, PLS-SEM, and hierarchical regression find a statistically significant and positive link between FinTech adoption and financial institutions' green activities. No significant moderating effects of education and experience are observed. Based on the results, the study highlights important policy and practical implications.

Keywords: *FinTech; Green Activities; Sustainability; Saudi Arabia; PLS-SEM.*

1. Introduction

1.1. Research background

The accelerating effects of climate change have led the world to a profound environmental transformation. Developing economies, including Saudi Arabia, are exploring sustainable solutions to address vulnerabilities due to resource dependency, environmental pressures, and rapid industrialization (Al-Hakimi et al., 2022; Zaid et al., 2025). Moreover, in recent years, in the financial sector, environmental sustainability and performance have become a topic of discussion among practitioners and researchers (Guang-Wen & Siddik, 2023). To enhance environmental performance and sustain their business, the financial sector is increasingly adopting measures like FinTech and Green finance, especially during crisis periods (Guang-Wen & Siddik, 2023), which have recorded remarkable progress due to an increase in contactless payments (Yan et al., 2023). The adoption of innovative technologies, such as online banking, crowdfunding, robo-advisors, and blockchain, businesses are significantly contributing to their sustainability performance (Akter et al., 2018).
Considering the case of Saudi Arabia, where digital infrastructure and FinTech adoption are rapidly evolving, there is a need to investigate whether the adoption of FinTech contributes to financial institutions' sustainability initiatives, including green activities (Zaid et al., 2025), such as the use of energy-efficient systems, introducing online facilities, promoting eco-friendly practices, and reducing paper consumption. Thus, the current study aims to examine the relationship between FinTech and green activities of financial institutions in Saudi Arabia. The study also investigates the role of demographic characteristics, including respondents' experience and education.
The following are the research questions of the current study:

1) Does FinTech positively impact financial institutions' green activities in Saudi Arabia?
2) What is the role of education and experience in the relationship between FinTech and financial institutions' green activities?

In the following section, the theoretical background is discussed, which provides a roadmap that contextualizes and justifies the research questions, suggesting how the study fits into existing knowledge; thus, establishing the foundation of the study.

1.2. Theoretical background

Considering the theoretical background of the current study, the practice-based view (PBV) is identified as one of the relevant theoretical frameworks. According to Bromiley and Rau (2014), the PBV assumes business performance with respect to generally attainable and recognized activities that companies may engage in. The PBV, in contrast to the Resource-Based View (RBV), highlights practices that are common, routinized, and imitable, while the latter chooses unique, valuable, and hard-to-copy resources as the main determinants of

organizational performance (Bromiley & Rau, 2014). In the case of financial institutions, the adoption of FinTech should be understood as a lot of operational and managerial practices; for instance, automated sustainability reporting, digital green-loan underwriting, blockchain traceability, and mobile green-payment systems that can be transferred and routinized across organizational divisions (Siddik et al., 2023). PBV argues that such practices translate strategies on sustainability into everyday actions and decision-making rules that govern the design of products, the criteria for client selection, and the monitoring of environmental performance (Tang et al., 2022; Khan et al., 2022). Previous empirical research observes that FinTech is a major facilitator of green and circular practices through the reduction of transaction costs and the improvement of information flows, which in turn, allows the institutions to carry out green lending and investor matching more accurately (Siddik et al., 2023). Overall, PBV accentuates micro-processes: employee training, standard operating procedures, and monitoring metrics are the elements that determine whether FinTech practices will yield greener outcomes or not (Bromiley & Rau, 2014). There are various factors, such as employees' educational background, that have a direct effect on the speed of and the extent to which the new practices are adopted, such as more highly trained and experienced personnel can adopt the new sustainable practices faster based on FinTech, which results in a greater level of sustainability outputs (Siddik et al., 2023).

The Dynamic Capabilities Theory (DCT) is also relevant in the current case, which describes how companies sense opportunity, capture it, and reconfigure resources to ensure performance in complex environments (Teece, 1997; Teece, 2014). FinTech is a facilitator within a capability cycle: institutions perceive sustainability demand and regulatory cues; grasp opportunities through the use of digital tools (e.g., green bond platforms, big-data green risk models); and rework legacy systems and governance to incorporate green portfolios (Siddik et al., 2023). The theory further approaches dynamic capability as an evolving ability that enables organizations to acquire, assimilate, and exploit green practice-required knowledge (Volberda et al., 2010; Dzhengiz & Niesten, 2020). DCT emphasizes continuous learning, inter-unit coordination, and governance—as opposed to having technology itself—as the driver of sustainable green performance (Teece, 2014). Previous research suggests that FinTech is helping to make green lending and investor matching feasible, but for green transformation to be sustainable, organizations must be able to reconfigure resources, update processes, and learn from their data (Siddik et al., 2023; Delmas et al., 2011). Experience and training make sensing and reconfiguration stronger: human capital can make the firm better able to interpret market signals (sensing) and integrate FinTech for strategic change.

PBV and DCT offer complementary levels of explanation. PBV accounts for the micro-level path, i.e., how FinTech comes in the form of tangible, routinized practices (digital green-loan procedures, automated ESG disclosure) that alter day-to-day decisions and operations (Bromiley & Rau, 2014; Siddik et al., 2023). On the other hand, DCT accounts for the meso/strategic path: how organisations build capabilities to capture green opportunities, take them through FinTech deployment, and reorganize assets and governance to maintain green portfolios (Teece, 1997; Teece, 2014). For the Saudi/Arabian green-finance environment (and other policy-forced markets), FinTech practices create short-term operating paths while dynamic capabilities decide if those paths scale and endure. Experience and education moderate both, i.e., they hasten the routinisation of practices (PBV) and enhance sensing, learning, and reconfiguration (DCT). Combining these theories explains how (practices) and why (capabilities) FinTech adoption can deliver enduring green outcomes for financial institutions.

2. Literature Review

The whole suite of FinTech technologies, comprising digital payment platforms, blockchain, AI, and online lending, is seen as enablers of sustainable business models (Bayram et al., 2022; Pizzi et al., 2021). Apart from going digital, financial institutions can also measure the carbon footprint, lend to green projects, and create environmental awareness among their customers with FinTech. In emerging economies, especially in Saudi Arabia, the acceptance of FinTech corresponds to the Saudi Vision 2030 of being a diversified and green economy (Aboalsamh et al., 2023). The introduction of digital financial solutions gives rise to green credit lines, digital statements, and sustainability-linked investment portfolios.

Various studies support the impact of FinTech innovation in promoting green economic development, especially through the justification of capital allocation and the transparency in green financing (Zhou et al., 2022; Mertzanis, 2023). The capital gains are in line with both the practice-based view (PBV) and the dynamic-capabilities theory (DCT) that explain the tech practices and the flexibility in learning as the two factors that enable organizations to instill sustainability into their culture. FinTech creates the organization's digital eco-friendly practices, including internet banking, auto reporting, and blockchain verification, that become a part of the organization's daily operations (Bromiley & Rau, 2014). Simultaneously, DCT states that firms that detect, grasp, and FinTech-related resource reshuffle get strategic empowerment in the application of eco-friendly innovations (Teece, 2014).

The workforce becomes the key factor that determines whether FinTech adoption translates into environmental results or not. Digital literacy and analysis help organizations to adopt and implement FinTech in such a way that enables sustainability reporting and green funding (Li et al., 2021; Lee & Lee, 2022). Empirical research shows that workers and managers with higher education are more eco-friendly conscious, and they are more likely to use the FinTech tools for eco-innovation (Aboalsamh et al., 2023; Tian et al., 2023). Besides, there is always the driving force of performance through experience since it enables understanding financial processes, risk rating, and regulation better. The skilled and experienced individuals, such as the practitioners, will be able to use FinTech to innovate by offering ecological loans, reducing the usage of paper, and improving their energy efficiency (Guang-Wen & Siddik, 2023). Education and experience are two factors that effectively develop an organization's absorptive capacity; the ability to absorb and apply new technology (Volberda et al., 2010). Thus, these demographic factors can act as moderators in the relationship between FinTech and sustainability outcomes. The literature review suggests that there is a beneficial relationship between FinTech adoption and green activities and that the effect could be stronger by increasing experience and education.

Based on the review of previous literature, it is observed that innovation or Fintech adoption supports environmental outcomes, including green financial activities. However, research also shows crucial gaps. Previous research has provided evidence on the positive impact of FinTech innovation on green growth by increasing green investment and green credit, where the key transmission channel is green finance (Zhou et al., 2022); however, these transmission channels or mechanisms are fully not consistent, such as green investment/credit, circular-economy practices, or green innovation are different sustainability measures foregrounded in fintech and green outcome models. One of the studies also observed that FinTech adoption's positive effect is dampened by better access to finance, which contradicts the view that more FinTech and more finance reinforce green outcomes (Siddik et al., 2023). With mostly policy-oriented and descriptive contributions, it also observed that green FinTech remains under-researched, especially in the emerging markets where green finance is differently shaped by regulatory capacity and Islamic finance (Bayram et al., 2022).

Moreover, there is a narrow sectoral and geographical focus and limited evidence on Saudi or Gulf finance systems. The positive relationship between FinTech and green finance could differ in Saudi Arabia, considering its different regulatory, economic, and institutional

characteristics. In the context of Saudi manufacturing SMEs, previous research reveals that access to finance improves the link between FinTech adoption and green innovation (Al Doghan & Chong, 2023). However, another research in the Saudi banking sector observes no moderating effect of FinTech adoption on the associations between financial innovation, environmental finance, and sustainability performance, showing a lack of integration of FinTech into sustainability processes (Zaid et al., 2024). It suggests that the green impact of FinTech relies on local financial infrastructure and sector-specific maturity. Qualitative evidence on the link between FinTech and green activities in Saudi Arabia has observed that concerns over data governance and privacy, low public awareness, and regulatory frameworks limit green-FinTech solutions' effective deployment (Aboalsamh et al., 2023). The review of previous literature also reveals the need for establishing causality or dynamic learning effects, with multi-level and longitudinal research. These inconsistencies and gaps justify the Saudi Arabian focus of the current research and position the work to connect FinTech adoption and green finance outcomes.

While the above literature broadly confirms the positive link between FinTech and green finance by widening financial inclusion, reducing transaction costs, and improving information flows, the evidence remains theoretically inconsistent and fragmented. Previous research disagrees on whether FinTech disrupts or complements traditional banking. Moreover, mixed evidence exists on whether the impact of FinTech on environmental outcomes is direct or indirect (through innovation, investment, or green credit). Moreover, due to regional disparities, limited empirical designs, and short time frames, the causal pathways remain uncertain, suggesting that the effect of FinTech adoption is context dependent.

3. Hypotheses Development

The incorporation of FinTech solutions results in improved environmental practices within the firms through the automation of operations, higher access to financing for environmentally friendly projects, and higher sustainability (Pizzi et al., 2021). Based on previous studies (Bayram et al., 2022; Chueca Vergara & Ferruz Agudo, 2021), various technologies, such as online platforms, online banking, and blockchains, are facilitating the process of securing money for green projects faster and more conveniently, in addition to conserving paper and energy. Researchers argue that FinTech is becoming the main driver of green and circular-economy initiatives by providing capital to the renewable and low-carbon sectors (Zhou et al., 2022; Mertzanis, 2023). In Saudi Arabia, which is transforming its economy towards a more sustainable one, in line with Vision 2030, the digital finance sector plays a key role in the country's sustainability effort by incorporating digital tools into the national green-finance policies (Aboalsamh et al., 2023).

The dynamic-capabilities model suggests that FinTech reinforces the institutions' power to identify and reallocate resources for environmental opportunities. This, in turn, leads to the creation of new sustainable products and green lending schemes (Teece, 2014). Thus, FinTech is not just a collection of financial technologies, but rather a tool that promotes and institutionalizes sound environmental practices like moratoriums on paper use, eco-friendly loans, energy-efficient operations, and better environmental monitoring systems. The reduction in transaction costs associated with clearly defined information flows helps environmental projects to be more attractive to investors, thus speeding up the flow of funds into green finance (Bayram et al., 2022). Therefore, the present research conceptualizes that FinTech has a significant positive effect on green activities.

H1: FinTech has a significant positive impact on Green Activities

Li et al. (2021) argue that cognitive capacity in understanding technological change and sustainability imperatives is largely dependent on education. Education is seen as a key factor in supporting the Theory of Planned Behavior when it comes to the adoption of green innovations by increasing the perceived behavioral control and positive attitudes (La Barbera & Ajzen, 2021). Previous research has shown that the more educated the employees and managers are, the more likely they are to adopt FinTech tools into sustainable business models and environmental programs (Tian et al., 2023). Educational programs do not only give rise to digital literacy but also critical thinking and problem-solving skills, which are needed for FinTech professionals to transform FinTech functionalities like data analytics and blockchain reporting into actual green outcomes (Lee & Lee, 2022; Pizzi et al., 2021). The literature of organizational learning also supports the fact that education promotes absorptive capacity, which means that firms can integrate and use new technical knowledge effectively (Volberda et al., 2010). It means that higher education gives FinTech adoption a greater chance of being done correctly and lasting; thus, the latter's influence on ecological practices and environmental performance becomes stronger. Moreover, formal schooling is an important factor in the decision-making process of management, in the improvement of governance for sustainability projects, and in the support of continuously running training courses that instill FinTech-backed green practices (Aboalsamh et al., 2023). This means that education acts as a moderator that enhances green activities and the translation of FinTech capabilities into the measurement of green outcomes.

H2: Education moderates the relationship between FinTech and Green Activities

Across the board, professional experience boosts knowledge about financial operations, regulatory frameworks, and digital means, thus allowing practitioners to apply FinTech more efficiently in the case of sustainability objectives (Guang-Wen & Siddik, 2023). Experienced managers are more likely to better read the market and social signals as well as the regulatory incentives for green finance, thus FinTech solutions such as green credit scoring, risk analytics, and eco-loan platforms will be deployed more effectively (Aggarwal et al., 2023; Mertzanis, 2023). Previous research suggests that experience gives an organization the power to sense, seize, and reconfigure, which are the very qualities that facilitate the transformation of technology adoption into a permanent and widespread green innovation (Teece et al., 1997). Going through technology experience takes the perceived behavioral control up so that the resistance to change in the process is at a minimum, and the coordination among the different units of the organization during the integration of technology becomes smoother (Anshari & Almunawar, 2022). This way, one can say that professional experience has a moderating effect on the linkage between FinTech and green activities through its contribution to the quality of implementation, strategic alignment, and ability to scale up successful green practices.

H3: Experience moderates the relationship between FinTech and Green Activities.

4. Methodology

4.1. Methodological design

It is important to present a methodological framework that is used to investigate the research problem and evaluate the proposed hypotheses (Hair et al., 2007). In this study, the core focus is to assess the relationship between FinTech adoption and Financial Institutions' Green Activities. Moreover, education and experience are included in the model as moderating factors, based on the premise that they may enhance this relationship. A quantitative approach was adopted, with data gathered through a self-administered survey. Quantitative methodology is appropriate in this study to gain statistical evidence (Hair et al., 2007). Financial institutions in Saudi Arabia (KSA) were

selected as the focus of this research due to the country's increasing investment in FinTech, providing a relevant context to examine its influence on green financial institution activities. The unit of analysis consisted of individuals in supervisory or executive roles within these institutions.

4.2. Data analysis

IBM SPSS (Version 27) was utilized for data coding, descriptive, and bivariate (correlation) analysis. For advanced statistical modeling, Partial Least Squares Structural Equation Modeling (PLS-SEM) was conducted using SmartPLS (Version 4) to evaluate both measurement and structural models. PLS-SEM is a widely used multivariate analysis technique for estimating path models involving latent constructs (Hair et al., 2021). Moreover, hierarchical regression analysis was also performed using SPSS to validate the PLS-SEM results.

The measurement model was assessed using Confirmatory Factor Analysis (CFA) to validate the underlying factor structure. This included evaluating indicator reliability through factor loadings and measuring internal consistency using Cronbach's alpha and Composite Reliability (CR). Convergent validity was determined by calculating the Average Variance Extracted (AVE), while discriminant validity was assessed using both the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT). Subsequently, the structural model was analyzed to test the hypothesized relationships among latent variables. Path analysis was employed to assess the significance and strength of these relationships, providing empirical evidence for the proposed hypotheses.

4.3. Instrument development

Data were collected through a structured questionnaire within a comprehensive survey project distributed to financial institutions in Saudi Arabia. The survey recorded respondents' demographic characteristics, including gender, age, highest level of education, years of experience, and job role, measured using single-select, closed-ended questions (nominal and ordinal variables). FinTech adoption was measured on a five-item Likert scale, from strongly disagree (1) to strongly agree (5). These items measured the extent of FinTech adoption in a financial institution; for example, our financial institution is committed to staying at the forefront of technological advancements and seamlessly integrating them into our services. The total number of items was five. Similarly, green activities were also measured on a five-item Likert scale, from strongly disagree (1) to strongly agree (5). This variable measured the extent to which a financial institution is involved in green initiatives; for example, one of the items is our financial institution is introducing energy-efficient systems, solutions, and practices. Green activities were measured by seven items. The measurement scale of FinTech adoption was sourced from multiple sources, including Chao et al. (2024), Hammoud et al. (2018), and Apau and Lallie (2022). On the other hand, the measurement scale of green activities is based on Chen et al. (2022).

4.4. Sampling and data collection

To determine the required sample size, the Partial Least Squares (PLS) approach was considered. A commonly applied guideline is the "10-times rule" proposed by Hair et al. (2017), which suggests that the sample size should be at least ten times the highest number of structural paths (outer model links) directed toward any latent construct in the model. In this study, a total of 12 outer model links were identified, indicating a minimum sample size requirement of 120 respondents ($12 \times 10 = 120$).

A purposive sampling technique was employed, targeting individuals in relevant positions within these institutions. This sampling technique is commonly used since it is less expensive than probability sampling methods (Acharya et al., 2013). The survey was administered online via Google Forms and made available in both Arabic and English to accommodate participants' language preferences. Data collection was conducted between April 2024 and May 2025.

During data collection, 419 responses were received via Google Forms, exceeding the minimum required sample size and deemed sufficient for analysis. The responses were coded into SPSS for initial screening. To identify invalid responses—such as duplicates or repetitive answer patterns across dimensions—standard deviation values of Likert-scale items were examined. This process flagged 108 invalid responses, which were excluded. Next, outlier detection was performed using Cook's Distance, with a threshold of 0.1 as recommended by Weinberg and Abramowitz (2008). Seven additional influential observations were identified and removed. After these data cleaning steps, the final sample comprised 304 valid responses.

Respondents Profile

Table 1 presents the counts and percentages of respondent demographics. The majority were male (n = 244, 80.3%), while females comprised 19.7% (n = 60), highlighting the persistent gender gap in senior roles within Saudi financial institutions. Age-wise, most participants were between 31 and 40 years old (n = 150, 49.3%), followed by those aged 20–30 (n = 115, 37.8%). Respondents aged 41–50 accounted for 11.5% (n = 35), and only 1.3% (n = 4) were 51 or older.

The frequency analysis of respondents' education revealed that over half of the sample held a bachelor's degree (n = 172, 56.6%), with diploma holders making up 28.9% (n = 88). It was followed by master's degree holders (n = 34, 11.2%), and high school graduates (n = 9, 3.0%), Regarding work experience, 37.2% (n = 113) had 5–10 years, 32.2% (n = 98) less than 5 years, 16.4% (n = 50) 11–15 years, and 14.1% (n = 43) over 15 years. In terms of organizational roles, managers represented 36.5% (n = 111), executives 32.9% (n = 100), and other supervisory positions 30.6% (n = 93).

Table 1: Respondents Profile (N= 304)

	Category	N [%]
Gender	Male	244 [80.3%]
	Female	60 [19.7%]
Age	20-30 years	115 [37.8%]
	31-40 years	150 [49.3%]
	41-50 years	35 [11.5%]
	51 years and older	4 [1.3%]
Education	High school	9 [3.0%]
	Diploma	88 [28.9%]
	Bachelor	172 [56.6%]
	Master	34 [11.2%]
	Ph.D.	1 [0.3%]
	Less than 5 years	98 [32.2%]

Experience	5-10	113 [37.2%]
	11-15	50 [16.4%]
	More than 15 years	43 [14.1%]
Role	Executive	100 [32.9%]
	Manager	111 [36.5%]
	Other	93 [30.6%]

Normality.

The study tested the assumption of normal distribution before running parametric tests. Normality was assessed using skewness and kurtosis, with values between ±2.3 considered acceptable (George, 2011). All constructs fell within this range, indicating no significant normality violations. For example, FinTech showed skewness of –0.869 and kurtosis of –0.581, while Green Institutional Activities had skewness of –0.517 and kurtosis of –0.628. These results affirm that data distribution is suitable for subsequent statistical analyses.

Measurement Model

The assessment of the PLS-SEM model began with an evaluation of the measurement model, a vital step to confirm the reliability and validity of the constructs (Hair et al., 2021). This evaluation involves three essential aspects: (1) internal consistency, assessed through Cronbach's alpha (CA > 0.70) and composite reliability (CR > 0.70); (2) convergent validity, examined via indicator reliability (factor loadings > 0.70) and average variance extracted (AVE > 0.50); and (3) discriminant validity, evaluated using the Fornell–Larcker criterion, cross-loadings, and the Heterotrait–Monotrait (HTMT) ratio.

As indicated in Table 2, the constructs demonstrated excellent internal consistency, with Cronbach's alpha values ranging from 0.936 (Green Financial Institutions Activities) to 0.965 (FinTech), comfortably surpassing the recommended threshold. Composite reliability values also confirmed this consistency, ranging between 0.948 and 0.973. Convergent validity was substantiated by all factor loadings exceeding 0.70 and AVE values between 0.722 and 0.878, well above the minimum acceptable level. Together, these results confirm that the measurement model reliably captures the intended constructs with adequate convergent validity.

Table 2: Estimates of Measurement Model Reliability, and Convergent Validity Estimates (N= 304)

Latent variable	Item	Loading	t-value	Alpha	CR	AVE
FinTech	FinTech_1	0.926	76.520***	0.965	0. 973	0.878
	FinTech_2	0.950	113.233***			
	FinTech_3	0.936	70.467***			
	FinTech_4	0.930	104.667***			
	FinTech_5	0.944	98.953***			
Green Financial Institutions Activities	GFIA_1	0.866	47.747***	0.936	0.948	0.722
	GFIA_2	0.850	51.513***			
	GFIA_3	0.845	38.357***			
	GFIA_4	0.837	35.418***			
	GFIA_5	0.849	40.799***			
	GFIA_6	0.850	42.084***			
	GFIA_7	0.850	40.750***			

*** P < 0.001.

Regarding discriminant validity, the HTMT criterion results shown in Table 3 indicate that all HTMT values were below the threshold of 1.0, in line with Henseler et al. (2015), confirming satisfactory discriminant validity. Additionally, using the Fornell and Larcker (1981) criterion, the square roots of the AVE values (presented on the diagonal) exceeded the corresponding inter-construct correlations (below the diagonal), further supporting discriminant validity among the constructs. Cross-loadings, also presented in Table 4, reinforced this conclusion, as each item exhibited higher loadings on its associated construct compared to other constructs.

Table 3: Discriminant Validity Checks Through HTMT and Fornell and Larcker Estimates (N= 304)

	FinTech	Green Financial Institutions Activities
FinTech	0,937	0.792
Green Financial Institutions Activities	0,765	0,850

Table 4: Discriminant Validity Evaluation Through Cross-Loading Estimates (N=304)

	FinTech	Green Financial Institutions Activities
FinTech_1	0.926	0.702
FinTech_2	0.950	0.739
FinTech_3	0.936	0.690
FinTech_4	0.930	0.743
FinTech_5	0.944	0.708
GFIA_1	0.656	0.866
GFIA_2	0.764	0.850
GFIA_3	0.605	0.845
GFIA_4	0.541	0.837
GFIA_5	0.567	0.849
GFIA_6	0.610	0.850
GFIA_7	0.742	0.850

5. Results

5.1. Descriptive statistics and correlations

Referring to Table 5, respondents rated FinTech relatively high, with a mean of 3.68 and a standard deviation of 1.31. Green Financial Institutions Activities received a moderate rating, with a mean of 3.37 and a standard deviation of 1.11. The standard deviations above 1 suggest some variability in responses, likely reflecting differences across the surveyed financial institutions in Saudi Arabia.

Overall, the mean scores indicate that while FinTech is well-established, there remains room for improvement in the green activities of the financial institutions. This highlights the need for increased efforts to strengthen sustainability practices within Saudi financial institutions for a more balanced institutional development.

Pearson correlation is used as a preliminary statistical test to investigate bivariate relationships between the variables. The analysis showed a strong and significant positive relationship between FinTech and green activities ($r = 0.756$, $p < 0.01$), providing initial empirical support for the proposed model's hypotheses.

Table 5: Results by Descriptive Analysis (N= 304)

Factor	Mean	Std.	Min	Max	Pearson Corr (1)	(2)
FinTech (1)	3.68	1.31	1.00	5.00	1	
Green Financial Institutions Activities (2)	3.37	1.11	1.00	5.00	0.756**	1

** Correlation is significant at the (0.01) level.

5.2. Structural model and hypotheses testing

To investigate the relationships between the model variables, the structural model was assessed. Predictive accuracy was evaluated using the R^2 value for each endogenous construct, with values above 10% considered acceptable (Falk & Miller, 1992). In this study, the R^2 value was 0.586, indicating that FinTech explains 58.6% of the variance in Green Financial Institutions Activities.

Prior to estimating path coefficients and significance through bootstrapping (5,000 subsamples), multicollinearity was examined using the Variance Inflation Factor (VIF). VIF values below 10 are acceptable, while values under 5 are preferable to confirm the absence of collinearity issues (Hair et al., 2017). The model showed no multicollinearity concerns, with all VIF values below 10.

After assessing the structural model's quality, hypothesis testing was conducted. Two models were evaluated: the first examined the direct effect of FinTech on Green Financial Institutions' Activities, while the second incorporated moderators.

In the first structural model (Figure 1), FinTech was hypothesized to significantly affect Green Financial Institutions Activities. The results confirmed this, revealing a strong and statistically significant effect [$B = 0.765$, $t = 26.005$, $CI = 0.703–0.819$, $p < 0.05$], thus supporting H1. This indicates that a one-unit increase in FinTech adoption corresponds to a 0.765-unit improvement in Green Financial Institutions Activities.

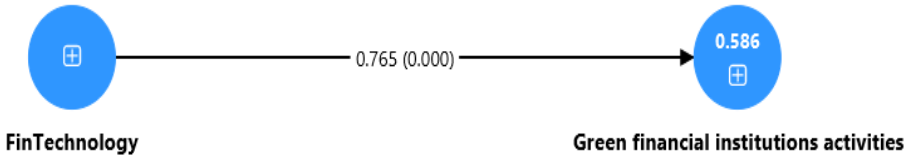

Fig. 1: Structural Model Estimates for the Influence of Fintech on Green Financial Institutions Activities.

The second structural model, shown in Figure 2, incorporated education and experience as moderators of the previously examined relationship.

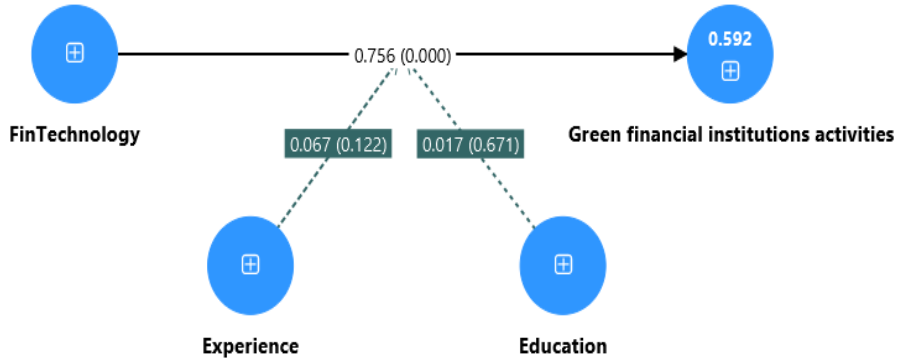

Fig. 2: Structural Model Estimates for the Moderation Influence of Education and Experience Over the Influence of Fintech on Green Financial Institutions Activities.

A moderation effect was proposed in H2, suggesting that the positive relationship between FinTech and Green Financial Institutions Activities would be amplified when supported by higher levels of education. However, the structural model estimation yielded the following results: FinTech × Education → Green Financial Institutions Activities [$\beta = 0.017$, $t = 0.425$, $CI = -0.060$ to 0.096, $p = 0.671$]. This interaction effect was not statistically significant at the conventional 0.05 level. Although the coefficient was positive, it indicated that education may enhance the impact of FinTech on Green Financial Institutions Activities—the effect was not strong enough to reach significance. Therefore, H2 is not supported. Figure 3 illustrates the moderation analysis of FinTech × Education → Green Financial Institutions Activities using a simple slope analysis.

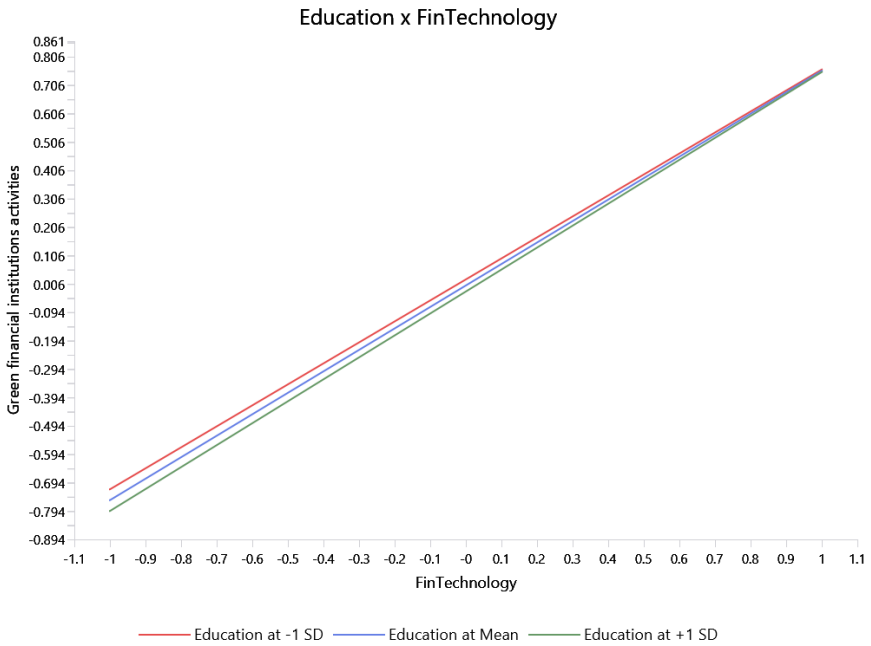

Fig. 3: The Moderation Analysis of Fintech × Education Green Financial Institutions Activities Using A Simple Slope Analysis.

A moderation effect was proposed in H3, positing that the positive relationship between FinTech and Green Financial Institutions Activities would be strengthened in the presence of greater professional experience. However, the structural model estimation produced the following results: FinTech × Experience → Green Financial Institutions Activities [β = 0.067, t = 1.548, CI = –0.014 to 0.155, p = 0.122]. This interaction effect did not reach statistical significance at the conventional 0.05 threshold. While the positive coefficient suggests that experience may enhance the influence of FinTech on Green Financial Institutions Activities, the effect was insufficient to establish statistical support. Accordingly, H3 is not supported. The moderation analysis of FinTech × Experience → Green Financial Institutions Activities is illustrated in Figure 4 through a simple slope analysis.

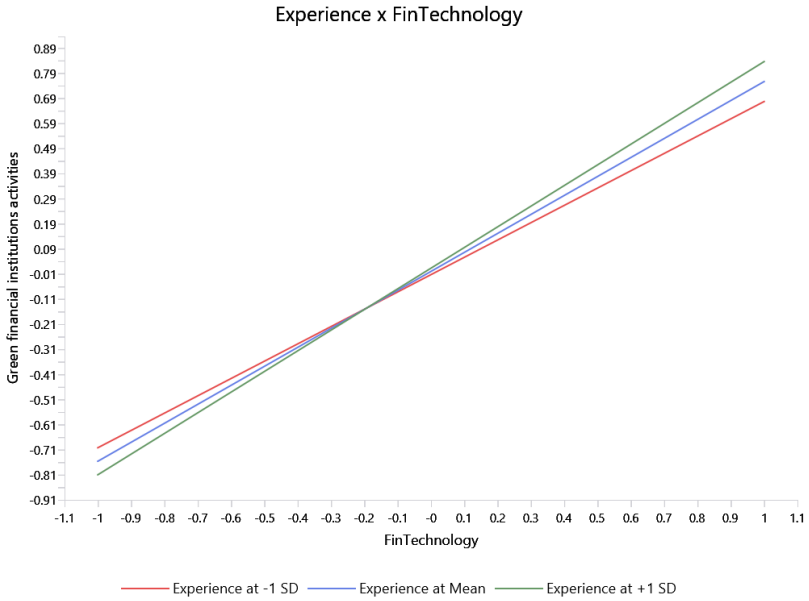

Fig. 4: The Moderation Analysis of Fintech × Experience Green Financial Institutions Activities Using A Simple Slope Analysis

The PLS SEM results reveal that H1 is supported, while H2 and H3 are not supported by statistical results (see Table 6).

Table 6: Results of Hypotheses Testing Through Structural Model Estimates (N= 304)

H	Path	B	t	P	CI	Decision
H1	FinTech → Green Financial Institution Activities	0.765	26.005	0.000*	0.695 – 0.815	Supported
H2	FinTech ×Education → Green Financial Institutions Activities	0.017	0.425	0.671	-0.060 – 0.096	Not supported
H3	FinTech ×Experience → Green Financial Institutions Activities	0.067	1.548	0.122	-0.014 – 0.155	Not supported

*P < 0.05.

To further validate the PLS-SEM results, specifically the moderation effect, hierarchical regression analysis was applied. The results are presented in Table 7. These findings confirmed the results obtained from the structural models, as similar outcomes were observed. FinTech showed a significant positive impact on Green Financial Institutions' activities. However, the moderators demonstrated a positive influence without reaching significance levels.

Table 7: Results of Hypotheses Testing Through Hierarchal Regression Estimates (N= 304)

n = 304 Variable		β Coefficient Model 1	Model 2	Model 3
Independent	FinTech	0.756 (0.000*)	0.754 (0.000*)	0.558 (0.000*)
Moderator	Education		-0.033 (0.388)	-0.078 (0.486)
	Experience		0.019 (0.620)	-0.174 (0.162)
Interaction effect	FinTech ×Education			0.075 (0.610)
	FinTech ×Experience			0.259 (0.096)
	R^2	0.571	0.573	0.578
	Adjusted R^2	0.570	0.568	0.571
	F	402.608 (0.000*)	133.973 (0.000*)	81.752 (0.000*)

*P < 0.05.

6. Discussion

The results of the structural model analysis provide valuable insights into the relationship between FinTech adoption and green activities within financial institutions in Saudi Arabia. The initial step involved checking for multicollinearity using the Variance Inflation Factor (VIF). All VIF values were below the critical threshold of 10, with most values clustered around 1, indicating that the model is free from multicollinearity concerns and that the estimates are robust and reliable (Hair et al., 2017).

The first structural model tested the direct effect of FinTech on Green Financial Institutions Activities. The results demonstrated a strong and statistically significant positive relationship, with a high path coefficient (β = 0.765) and a substantial t-value (t = 26.005), confirming the proposed hypothesis (H1). This suggests that financial institutions that adopt and integrate FinTech are likely to significantly enhance their Green Financial Institutions Activities. The finding aligns with existing literature that underscores the transformative potential of FinTech in promoting sustainable finance, operational efficiency, and environmentally responsible innovations within financial institutions (Aboalsamh et al., 2023; Pizzi et al., 2021).

In contrast, the second structural model, which introduced education and experience as moderators, yielded more nuanced outcomes. For education (H2), while the interaction term showed a positive coefficient (β = 0.017), the effect was statistically insignificant (p = 0.671). Similarly, for experience (H3), the interaction term was also positive (β = 0.067) but did not reach significance (p = 0.122). Although the direction of the moderation effects suggests a potential reinforcing role for both education and professional experience, the lack of statistical support implies that these factors do not significantly condition the strength of the relationship between FinTech and Green Financial Institutions Activities in the current sample.

These findings may be attributed to several contextual considerations. First, the variance in educational and experiential backgrounds among employees might not be substantial enough to detect a significant moderating effect. Alternatively, it is possible that institutional factors—such as organizational culture, leadership support, or regulatory frameworks—play a more critical role in enhancing the effectiveness of FinTech implementation than individual-level characteristics. Moreover, the rapid evolution of FinTech may require not just formal education or work experience, but continuous upskilling and institutional readiness to yield sustainable impact.

Previous research shows that green outcomes, which are FinTech driven, rely more on top-management direction, digital infrastructure, and organizational system rather than individual characteristics, such as experience and education. It is argued that sustainability-based technological transformations are shaped by cultural and structural factors, such as organizational routines, leadership climate, and digital literacy support, rather than demographic attributes (Pizzi et al., 2021; Kraus et al., 2020). It means that factors like experience and education may not impact the link between FinTech adoption and green initiatives.

The non-significant moderating effects of experience and education may also highlight sample-composition and measurement-related issues. For instance, broad categorical ranges, rather than skill-based or continuous measures, as moderators may not reflect meaningful differences adequately in sustainability or digital competencies. Previous research has argued that due to lack of construct precision, demographic moderators may fail to show significant influence, especially in studies focusing on technology and sustainability (Venkatesh et al., 2012).

Moreover, the sample distribution shows possible range restriction, decreasing the statistical power for detecting interaction effects. Although the sample size of the study is large, most participants of the study fall into 20-30 years and 30-40 years age group. Similarly, 0-10 years categories are most common, clustering large proportion (around 70%). Due to lack of sufficient variance to impact boundary conditions, moderation tests may fail (Dawson, 2014). It means that lack of moderation by experience and education is plausible theoretically and expected empirically.

Overall, the results underscore the pivotal role of FinTech in advancing environmental and sustainability initiatives within financial institutions in Saudi Arabia. However, the insignificant moderation effects suggest that simply having more educated or experienced staff may not be sufficient to amplify this relationship in the context of Saudi Arabia. Future studies could explore other moderating or mediating variables, such as digital literacy, organizational support, or innovation climate, to better understand the conditions under which FinTech can most effectively drive sustainable institutional transformation.

7. Conclusion

The objective of the current study was to examine the relationship between FinTech and green activities of financial institutions in Saudi Arabia. The study also investigated the role of demographic characteristics, including respondents' experience and education in the relationship between FinTech and green initiatives. This research study applied Pearson correlation, PLS-SEM and hierarchical regression to examine these effects and relationships. Most of the respondents of the study were male, 31-40 years old, held a bachelor's degree, and had 5-10 years of work experience. The Pearson correlation analysis revealed a significant, positive and strong relationship between FinTech and green activities. The PLS-SEM confirmed this result by finding a strong significant effect of FinTech on green financial institutions' activities. However, both moderation effects were statistically insignificant, suggesting that education and experience do not

affect the link between FinTech adoption and green initiatives. Thus, only H1 was supported, while H2 and H3 were not supported. The findings of hierarchical regression supported and validated the above results. Overall, the study is able to find a significant link between the main explanatory variable, i.e., FinTech adoption, and the outcome, i.e., financial institutions' green initiatives in the context of Saudi Arabia.

8. Policy and Practical Implications

The statistically significant and positive link between FinTech adoption and financial institutions' green activities in Saudi Arabia suggests that FinTech adoption has substantial policy and practical implications, which relate to stakeholder engagement, institutional transformation, and strategic regulation. Moreover, the findings show that FinTech usage may lead to transferable and repeatable practices, such as automated ESG reporting, digital green lending, and sustainable investment. It aligns with the PBV framework, i.e., publicly available and common FinTech practices can generate positive green outcomes. Although no significant moderating effects of education and experience are observed, the significant main effects show that by leveraging FinTech as a tool that enhances capability, the organizations are showing sustainability benefits, supporting the DCT view.

- Based on the results, there is a need to establish regulatory frameworks which support FinTech adoption for green activities, such as climate-focused financial products and digital sustainability incentives (Wen & Liu, 2023).
- Government authorities may link the adoption of FinTech to the sustainability goals of Vision 2030 by integrating pollution reduction measures, green finance tracking, and carbon accounting into national financial regulations (Yusuf & Lytras, 2023).
- Policies need to promote and support collaboration between financial institutions, FinTech, and environmental agencies (Yusuf & Lytras, 2023).
- To modernize internal processes for automating sustainability compliance and green reporting and evaluation, financial institutions, such as banks, can leverage FinTech (Wen & Liu, 2023). This would accelerate finance flow towards green projects, improve green project evaluation, and strengthen transparency.
- FinTech providers and financial institutions need to invest in talent development and create consumer education campaigns to improve digital literacy; this would allow them to adopt green financing tools, including green lending products, carbon tracking applications, etc.

Although a significant relationship between FinTech adoption and green financial activities is observed in the current study, the insignificant moderating effects of experience and education suggest empirical gaps that could be addressed in future studies. Future research may examine alternative moderators, such as digital literacy, green-oriented leadership, and organizational culture, that may better explain the link between FinTech adoption and green activities. Previous research has shown strong influences of factors like leadership commitment, learning climate, and internal values on tech-enabled sustainability outcomes and environmental practices (Singh et al., 2022; Kraus et al., 2020). Moreover, future research may explore the roles of data governance capability and capacity, innovation readiness, and top management support, offering deeper explanatory value (Chen et al., 2024).

Future studies may also consider other methodological approaches, such as mixed methods where quantitative survey data can be combined with case studies or qualitative interviews, which may capture contextual nuances, which could be overlooked by quantitative studies (Pizzi et al., 2021). In addition, scholars may consider adopting longitudinal designs to address cross-sectional data limitations, observing how FinTech and green activities evolve over time, thus providing stronger evidence of causal links.

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