Far Western Review
A Multidisciplinary, Peer Reviewed Journal
ISSN: 3021-9019
Published by Far Western University
Mahendranagar, Nepal

Effect of FinTech Adoption, Green Finance and Green Innovation on Sustainability Performance of Nepalese Financial Institutions

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Abstract

This study is aimed to investigate the impact of FinTech adoption on the sustainability performance of financial institutions of Nepal focusing the mediating role of green finance and green innovation. Employing a descriptive and causal-comparative research design, the research systematically describes the characteristics of FinTech adoption among customers of financial institutions of the selected area and explores potential cause-and-effect relationships between FinTech adoption and sustainability performance. Data were collected from 180 respondents through a structured questionnaire distributed via an online survey platform, utilizing a 5-point Likert scale. Confirmatory Factor Analysis (CFA) and Structural Equation Modeling (SEM) were used to test the measurement model and examine the relationships between the constructs. The study confirmed that FinTech adoption positively impacts sustainability performance and green finance, although it negatively influences green innovation. Mediation analysis revealed that neither green finance nor green innovation significantly mediate the relationship between FinTech adoption and sustainability performance. The findings underscore the necessity for financial institutions to integrate both technological advancements and sustainable practices comprehensively. This study contributes to the academic literature by providing empirical evidence from Nepal and offers practical insights for policymakers and financial institutions aiming to enhance sustainability through fintech. By addressing critical research gaps, this study advances

our understanding of how FinTech can be effectively aligned with sustainable financial practices in Nepal, ensuring long-term environmental, social, and economic benefits.

Keywords: FinTech adoption, green finance, green innovation, sustainability performance

Introduction

In recent decades, Nepal has experienced significant economic development (Devkota, 2007). The financial system in Nepal has evolved, adapting to global economic trends, characterized by the integration of Financial Technology (FinTech) with established financial institutions (Aryal et al., 2022). The advancement of digitalization and FinTech enhances accessibility, efficiency, and competitiveness (Bisht et al., 2022). This marks an essential moment for Nepal's financial industry, aligning with global advancements while meeting local demands (Niraula & Adhikari, 2019). Despite technological progress, sustainability has become a critical issue for businesses, including the banking sector, as it has become a global concern. Firms worldwide are increasingly aware of their long-term environmental and social impacts (Cai & Song, 2022). Sustainable practices enhance long-term sustainability and reputation (Ortiz-de-Mandojana & Bansal, 2016). The adoption of digital wallets, mobile banking, and online payment methods is increasing, particularly among the youth and in urban areas (Calisir & Gumussoy, 2008). FinTech adoption in Nepal offers benefits like increased financial inclusion, reduced transaction costs, and improved operational efficiency (Shah, 2016). Online payment methods, digital wallets, and mobile banking have become integral components of Nepal's financial system.

Balancing innovation and sustainability are crucial as Nepal's banking sector embraces technological advancements (Aryal et al., 2022). Sustainability in the financial sector means aligning activities with environmental, social, and governance factors. Financial institutions must be profitable while contributing to social and environmental well-being for long-term sustainability (Gautam, 2014). Aligning operations with sustainable practices presents financial institutions as responsible corporate citizens, reducing risks related to social inequality and climate change (Chaulagain, 2015; Pant, 2016). The relationship between FinTech adoption and sustainability involves efforts towards green finance and innovation (Siddik et al., 2023). Despite Fintech's potential to increase efficiency and accessibility, there is a significant knowledge gap regarding its impact on the sustainability performance of financial institutions. This gap challenges financial organizations in developing effective strategies and policymakers in guiding FinTech integration (Chaulagain, 2015; Pant, 2016). Additionally, research on the mediating role of green finance and green innovation in the relationship between FinTech adoption and sustainability performance is lacking (Yan et al., 2022).

Addressing these research gaps is essential for enhancing FinTech benefits and reducing negative impacts on sustainability performance (Gautam & Devkota, 2021). This understanding is vital for including FinTech into Nepal's financial industry and ensuring that FinTech innovations contribute positively to larger sustainability goals, reflecting Nepal's unique socioeconomic and environmental conditions (Niraula & Adhikari, 2019). Thus, understanding the complex relationships between FinTech adoption, sustainability performance, green finance, and green innovation is crucial for guiding policy decisions and shaping financial sector strategies. This paper aims to explore the effect of FinTech adoption, green finance strategies and green innovation practices on the sustainability performance of Nepalese financial institutions.

Literature Review

FinTech Adoption and Sustainability Performance

The integration of financial technology (Fintech) into traditional financial systems has shown a substantial influence on sustainability performance (Arner et al., 2020). FinTech innovations, such as digital banking, blockchain, and Artificial Intelligence (AI) driven financial services, enhance operational efficiency and transparency, leading to more sustainable business practices (Su et al., 2021). These technologies enable better resource management and reduce environmental footprints by optimizing energy consumption and minimizing waste (Su et al., 2021). Additionally, FinTech solutions facilitate the adoption of green finance by making it easier for investors to channel funds into sustainable projects (Chueca Vergara & Ferruz Agudo, 2021). This transformation not only supports environmental sustainability but also promotes social and economic sustainability by improving financial inclusion and access to financial services for underserved populations (Ahmad et al., 2022). Thus, this has led to the development of first hypothesis of the study which is as follows:

H1: There is a significant positive impact of FinTech adoption on sustainability performance.

FinTech Adoption and Green Finance

FinTech adoption plays a crucial role in advancing green finance by providing innovative platforms and tools that facilitate investment in environmentally friendly projects (Muganyi et al., 2021). Digital platforms and blockchain technology offer increased transparency and traceability, which are vital for ensuring the credibility and accountability of green finance initiatives (Park & Li, 2021). FinTech solutions also enable more efficient distribution of green bonds and other sustainable financial instruments, thereby attracting a broader range of investors (Nassiry, 2019). Furthermore, AI and big data analytics help in assessing the environmental impact of investments and identifying opportunities for green financing. These technological advancements support

the growth and effectiveness of green finance, contributing to the overall objective of sustainable development (Benzidia et al., 2021). Thus, this has led to the development of second hypothesis of the study which is as follows:

H2: There is a significant positive impact of FinTech adoption on green finance.

FinTech Adoption on Green Innovation

The adoption of FinTech is instrumental in driving green innovation across various industries. FinTech provides the necessary financial infrastructure to support startups and businesses focused on developing environmentally friendly technologies and solutions (Yan et al.,2022). Innovators can secure the capital needed to bring their green ideas to market through crowdfunding platforms, venture capital, and other Fintech-enabled funding mechanisms, (Sorenson et al., 2016). Moreover, FinTech tools like blockchain and Internet of Things (IoT) facilitate the creation of transparent and efficient supply chains, promoting sustainable practices and reducing carbon footprints. These technologies also allow real-time monitoring and reporting of environmental impacts, promoting a culture of continuous improvement and innovation in sustainability (Park & Li, 2021). Thus, this has led to the development of third hypothesis of the study which is as follows:

H3: There is a significant positive impact of FinTech adoption on green innovation.

Green Finance and Sustainability Performance

Green finance significantly contributes to enhancing sustainability performance by directing financial resources towards projects and initiatives that have positive environmental and social impacts (Khan et al., 2022). Investments in renewable energy, sustainable agriculture, and eco-friendly infrastructure are facilitated by green finance, leading to reduced greenhouse gas emissions and conservation of natural resources (Belgacem et al., 2023). Green finance also promotes corporate social responsibility by encouraging companies to adopt sustainable practices and technologies. This financial support not only helps in achieving environmental goals but also strengthens economic stability and social equity by creating green jobs and promoting inclusive growth (Wang et al., 2022). The positive outcomes of green finance are evident in the improved sustainability metrics of organizations and economies that actively engage in such financial practices (Xu et al., 2020). Thus, this has led to the development of fourth hypothesis of the study which is as follows:

H4: There is a significant positive impact of green finance on sustainability performance.

Green Innovation on Sustainability Performance

Green innovation is a key driver of improved sustainability performance, as it involves the development and implementation of new technologies and processes

that reduce environmental impacts and enhance resource efficiency (Li et al., 2020). Innovations such as renewable energy technologies, energy-efficient building materials, and sustainable agricultural practices contribute to significant reductions in carbon emissions and energy consumption (Hu et al., 2021). These advancements not only address environmental challenges but also provide economic benefits by reducing costs and creating new market opportunities. Furthermore, green innovation fosters social sustainability by promoting healthier lifestyles and improving quality of life (Nguyen Dang et al., 2021). Organizations that invest in green innovation typically realize improved sustainability performance, reflected in better environmental, economic, and social outcomes (Shahzad et al., 2020). Thus, this has led to the development of fifth hypothesis of the study which is as follows:

H5: There is a significant positive impact of green innovation on sustainability performance.

Green Finance as a Mediator between FinTech Adoption and Sustainability Performance

Green finance significantly contributes to enhancing sustainability performance by directing financial resources towards projects and initiatives that have positive environmental and social impacts (Yan et al., 2022). Investments in renewable energy, sustainable agriculture, and eco-friendly infrastructure are facilitated by green finance, leading to reduced greenhouse gas emissions and conservation of natural resources (Zhang, 2023). FinTech innovations enhance the efficiency and accessibility of green finance by streamlining the processes for green loans and sustainable investments, making it easier for financial institutions to support environmentally friendly projects (Hu & Li, 2023). This financial support not only helps in achieving environmental goals but also strengthens economic stability and social equity by creating green jobs and promoting inclusive growth (Muganyi et al., 2021). The positive outcomes of green finance are obvious in the improved sustainability indicators of organizations and economies that actively engage in such financial practices (Yan et al., 2022). Hence, the study suggests that green finance mediates the relationship between FinTech adoption and sustainability performance, leading to the sixth hypothesis:

H6: Green finance mediates the relationship between FinTech adoption and sustainability performance.

Green Innovation as a Mediator between FinTech Adoption and Sustainability Performance

Green innovation plays a key role in improving sustainability performance by promoting the development and implementation of new products, services, and processes that reduce environmental impact (Dangelico & Pujari, 2010). FinTech drives green

innovation by providing advanced technological tools that enable financial institutions to create and integrate eco-friendly solutions into their operations (Wang et al., 2022). Examples include the development of sustainable investment platforms and energy-efficient financial services, which FinTech solutions can facilitate (Lee & Min, 2015). These innovations not only reduce the environmental footprint of financial operations but also insert sustainability into the core business strategies of financial institutions. This integration of green practices leads to significant improvements in sustainability performance, as showed by the adoption of environmentally responsible technologies and the achievement of long-term ecological benefits (Dangelico & Pujari, 2010). Therefore, the study hypothesizes that green innovation mediates the relationship between FinTech adoption and sustainability performance, leading to the seventh hypothesis:

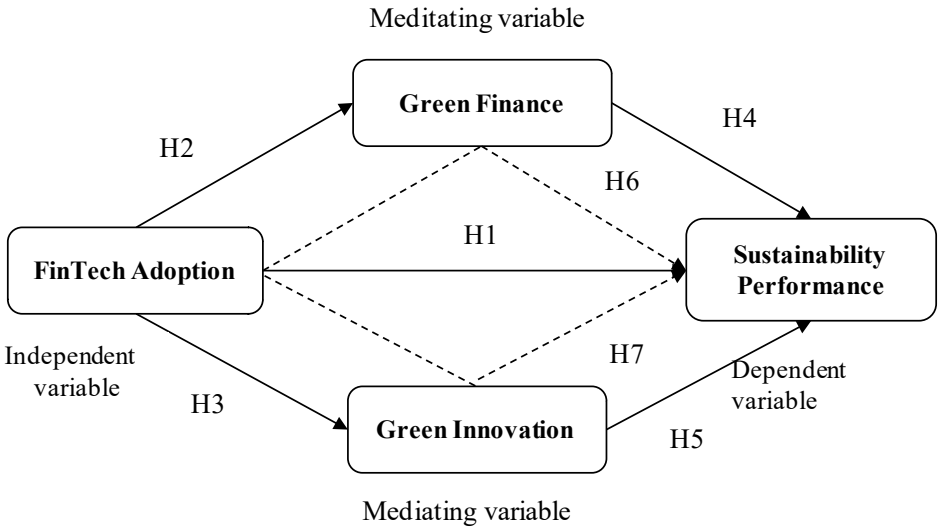
H7: Green innovation mediates the relationship between FinTech adoption and sustainability performance.

Theoretical Framework

Based on past empirical studies and above hypothesis, the theoretical framework of the study is as follows:

Figure 1

Theoretical Framework showing impact of FinTech adoption on sustainability performance with green finance and green innovation as mediating variables



Source: Yan et al, (2022)

Research Methodology

The primary objective of this research is to examine the impact of FinTech

adoption on the sustainability performance of financial institutions in Nepal, with a particular focus on the mediating roles of green finance and green innovation. The study adopts a descriptive and causal-comparative research design. The descriptive component aims to systematically describe the characteristics of the population and the phenomenon under study, specifically the adoption of FinTech solutions by customers of financial institutions in Nepal. Meanwhile, the causal-comparative aspect seeks to examine potential cause-and-effect relationships between FinTech adoption and sustainability performance, mediated by green finance and green innovation. The population for this study includes all customers of financial institutions in Nepal who are utilizing FinTech solutions. A representative and focused sample is ensured by selecting FinTech solution users located in Pokhara city through purposive sampling. This non-probability sampling method ensures that participants are relevant to the research objectives, specifically those with direct experience and insights into FinTech adoption. A sample size of 180 respondents is considered sufficient to conduct robust statistical analyses, including confirmatory factor analysis (CFA) and structural equation modeling (SEM), ensuring statistical power and reliability of results. Data is collected using a structured questionnaire distributed via an online survey platform, employing a 5-point Likert scale to measure responses ranging from "strongly disagree" to "strongly agree." The operationalization of FinTech adoption, green finance, green innovation, and sustainability performance is detailed in the study's appendix, with each variable defined based on established theoretical models and previous research. The validity of the questionnaire is ensured through rigorous testing for both convergent and discriminant validity. This testing confirms that the items within each construct are related and distinct from other constructs, respectively.

Internal reliability of the responses is evaluated using Cronbach's Alpha, ensuring consistency in measurement. CFA is conducted to verify convergent validity, confirming that the measurement model accurately represents the constructs under study. Additionally, common method bias is checked using the common factor approach to ensure the results are not excessively influenced by the measurement method. Data analysis involves the use of CFA and SEM to test the accuracy of the measured variables and to explore the relationships between the independent variable (FinTech adoption) and the dependent variable (sustainability performance). Mediation analysis is conducted to determine the extent to which green finance and green innovation mediate the relationship between FinTech adoption and sustainability performance. References for this study are drawn from credible sources, including scientific journals, books, and professional websites, ensuring the robustness and credibility of the research findings. This comprehensive approach provides valuable insights into the mediating roles of green finance and green innovation, contributing to both academic literature and practical

applications in the financial sector, ultimately advancing our understanding of the impact of FinTech on sustainable financial practices in Nepal.

Results and Discussion

Results

The study is based on the demographic profile of individuals utilizing FinTech services provided by different financial institutions in the Pokhara Valley. The profiles include gender, age, marital status, educational qualifications, work experience and monthly income. Data on these demographic variables were collected through the questionnaire and analyzed using SPSS, with results presented as percentages. The summarized demographic characteristics of respondents are presented in Table 1.

Table 1

Demographic Profile of Respondents

Demographic Profile	Sub Categories	Frequency	Percent
Gender	Male	130	72.2
	Female	50	27.8
Age	Between 20 to 30 years	77	42.8
	Between 30 to 40 years	69	38.3
	Between 40 to 50 years	28	15.6
	Above 50 years	6	3.3
Marital Status	Married	108	60
	Unmarried	66	36.7
	Others	6	3.3
Education	SLC	2	1.1
	Plus 2	25	13.9
	Bachelor	88	48.9
	Masters	65	36.1
Experience	Below 3 years	38	21.1
	Between 3-5 years	52	28.9
	Between 5-10 years	61	33.9
	Above 10 years	29	16.1
Income	Below Rs 30000	36	20
	Between Rs 30000 to Rs 50000	91	50.6
	Between Rs 50000 to Rs 80000	22	12.2
	Above Rs 80000	31	17.2
Total		180	100

Source: Field Survey, 2024

Table 1 showed that 72.2% of respondents were male and 27.8% female, possibly due to cultural and social norms influencing men's engagement in FinTech services is more than women. Age distribution showed 42.8% between 20-30 years, 38.3% between 30-40 years, 15.6% between 40-50 years, and 3.3% above 50 years. Younger individuals may be more tech-savvy, facilitating higher FinTech usage, while those in their prime working years are more financially active. Marital status indicated 60% married, 36.7% unmarried, and 3.3% in other categories, possibly reflecting different financial management needs and priorities. Educational qualifications ranged from 1.1% with SLC, 13.9% with Plus 2, 48.9% with Bachelor's degrees, to 36.1% with Master's degrees, suggesting that higher education levels could correlate with greater FinTech adoption due to better understanding and trust in digital services. Work experience varied with 21.1% below 3 years, 28.9% between 3-5 years, 33.9% between 5-10 years, and 16.1% above 10 years, indicating that individuals with more work experience might use FinTech services more for convenience and efficiency. Income levels were distributed as 20% earning below Rs 30,000, 50.6% between Rs 30,000 to Rs 50,000, 12.2% between Rs 50,000 to Rs 80,000, and 17.2% above Rs 80,000, suggesting that higher income groups may have more disposable income to invest in and benefit from FinTech services.

Reliability and Validity

Construct Reliability. Table 6 presents an assessment of construct reliability for key variables in the study, using both Cronbach's Alpha and Composite Reliability measures. The Cronbach's Alpha values, ranging from 0.754 to 0.815, indicate robust internal consistency for variables such as FinTech Adoption, sustainability performance, green finance, and green innovation. The composite reliability values, ranging from 0.793 to 0.862, further reinforce the reliability of these constructs. These findings demonstrate that the scales used to measure these variables exhibit strong internal reliability, enhancing the credibility and validity of the research outcomes on the impact of FinTech adoption on sustainability performance, with green finance and green innovation as mediating variables within financial institutions.

Table 6

Construct Reliability of Scale

Variables	Cronbach's Alpha	Composite Reliability
FinTech Adoption	0.754	0.793
Sustainability Performance	0.796	0.824
Green Finance	0.815	0.862
Green Innovation	0.786	0.835

Source: Field Survey, 2024

Construct Validity. Tables 7 and 8 collectively present the assessment of construct

validity, evaluating the accuracy with which concepts are measured in the study. Table 7 focuses on convergent and discriminant validity, showing that the Average Variance Extracted (AVE) values, ranging from 0.612 to 0.655, all exceed the recommended threshold of 0.50, indicating strong convergent validity. The Mean Shared Variance (MSV) values, ranging from 0.568 to 0.612, suggest that each construct shares more variance within itself than with other constructs confirming discriminant validity.

Table 7

Convergent and Discriminant Validity

Variables	AVE	MSV
FinTech Adoption	0.612	0.568
Sustainability Performance	0.629	0.572
Green Finance	0.655	0.592
Green Innovation	0.634	0.612

Source: Field Survey, 2024

Table 8 investigates into examining discriminant validity using the Fornell-Larcker criterion, which involves comparing the square root of the Average Variance Extracted (AVE) for each construct with the correlations between constructs. According to the Fornell-Larcker criterion, for adequate discriminant validity, the square root of AVE for each construct should be greater than its correlations with any other construct and this pattern holds for all constructs. This analysis confirms that the constructs are distinct from each other while accurately capturing their unique aspects.

Table 8

Square Root of AVE and Construct Correlation Analysis

Variables	FinTech Adoption	Sustainability Performance	Green Finance	Green Innovation
FinTech Adoption	0.782			
Sustainability Performance	0.526	0.793		
Green Finance	0.517	0.535	0.809	
Green Innovation	0.594	0.578	0.547	0.796

Source: Field Survey, 2024 and authors' calculation.

Common Method Bias using Latent Factor

Common method bias is a potential threat to the validity of research findings, which can arise when the measurement of constructs is affected by a single, common source of variance. Researchers can use a latent factor approach to detect and control for this bias by including a latent method factor in their analysis, which accounts for the common variance due to the method of measurement, and other latent factors that represent the constructs of interest. In this study common method bias using single

common factor is checked by comparing standard regression weight of CFA model with and without common factor. The figure for common method bias using single common factor is given by following figure

Figure 2

Common Method Bias using single common factor

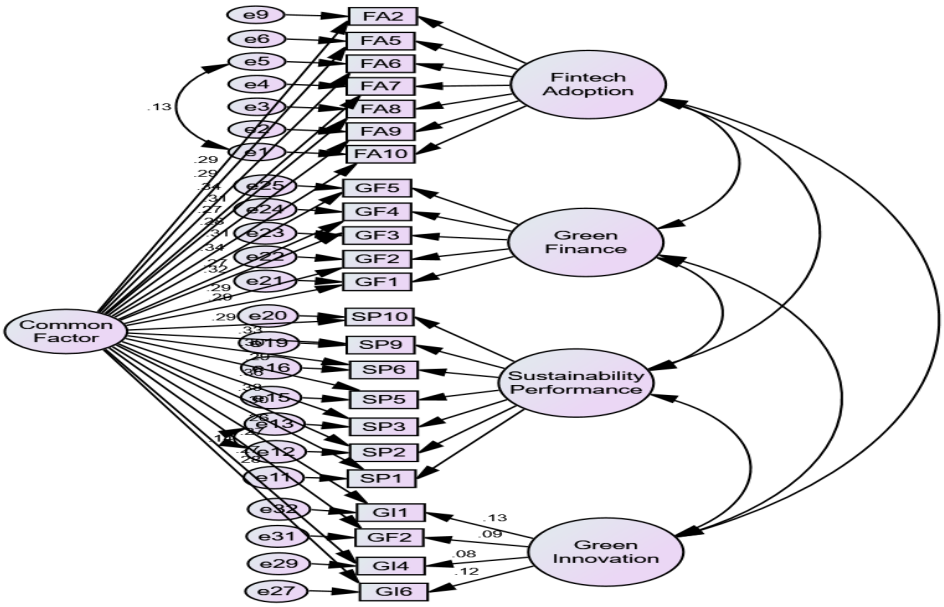


Table 9

Standard regression weight of CFA model with and without common factor

Relationship between Variable			Estimate without common factor	Estimate with common factor	Absolute Difference
FinAdop10	<---	Fintech_Adoption	0.192	0.31	0.118
FinAdop9	<---	Fintech_Adoption	0.375	0.277	0.098
FinAdop8	<---	Fintech_Adoption	0.141	0.268	0.127
FinAdop7	<---	Fintech_Adoption	0.231	0.307	0.076
FinAdop6	<---	Fintech_Adoption	0.193	0.337	0.144
FinAdop5	<---	Fintech_Adoption	0.227	0.291	0.064
FinAdop2	<---	Fintech_Adoption	0.227	0.29	0.063
SusPer1	<---	Sustainability_Performance	0.137	0.296	0.159
SusPer2	<---	Sustainability_Performance	0.185	0.326	0.141
SusPer3	<---	Sustainability_Performance	0.229	0.362	0.133

SusPer5	<---	Sustainability_Performance	0.12	0.289	0.169
SusPer6	<---	Sustainability_Performance	0.141	0.301	0.16
SusPer9	<---	Sustainability_Performance	0.441	0.331	0.11
SusPer10	<---	Sustainability_Performance	0.38	0.295	0.085
GreFin1	<---	Green_Finance	0.395	0.291	0.104
GreFin2	<---	Green_Finance	0.168	0.287	0.119
GreFin3	<---	Green_Finance	0.158	0.324	0.166
GreFin4	<---	Green_Finance	0.157	0.27	0.113
GreFin5	<---	Green_Finance	0.183	0.335	0.152
GreInn6	<---	Green_Innovation	0.289	0.119	0.17
GreInn4	<---	Green_Innovation	0.203	0.08	0.123
GreInn2	<---	Green_Innovation	0.135	0.088	0.047
GreInn1	<---	Green_Innovation	0.26	0.126	0.134

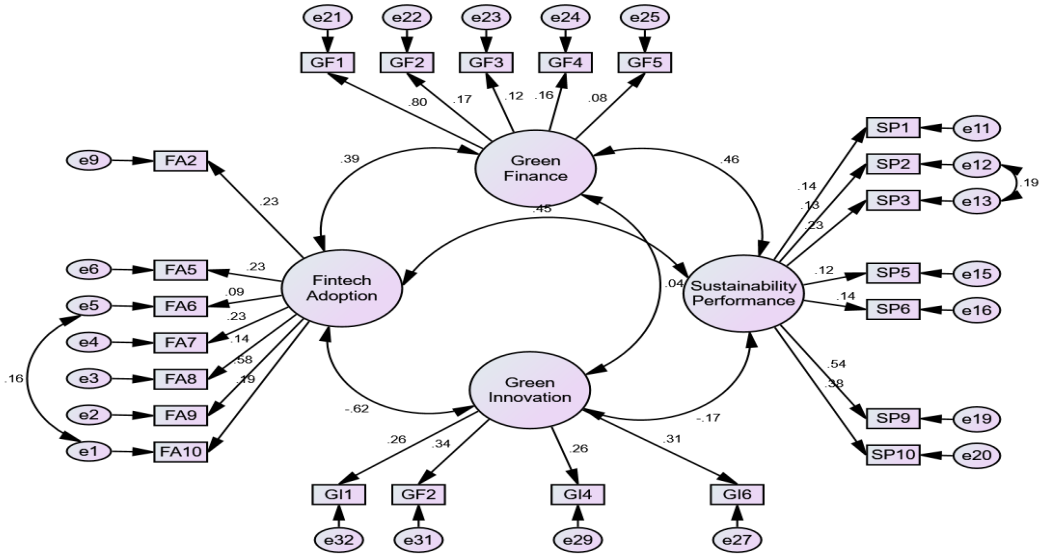
Table 9 indicate the result of comparison of standard regression weight of CFA model with and without common. As the absolute difference value from the table is less than 0.2, this indicate that there is no common method bias in the data, hence we can proceed further for confirmatory factor analysis (Serrano et al., 2018).

Confirmatory Factor Analysis

In this study, Confirmatory Factor Analysis (CFA) was employed to evaluate the validity of the measurement model using AMOS software (version 22), a well-regarded tool for Structural Equation Modeling (SEM). The maximum likelihood (ML) estimator, known for its unbiased and efficient properties under specific assumptions (Byrne, 2016), was used to estimate the model parameters. The CFA results demonstrated an excellent fit of the measurement model, as evidenced by various absolute fit indices, including the Goodness of Fit Index (GFI = 0.904), Adjusted Goodness of Fit Index (AGFI = 0.881), chi-square ($\chi 2$), and Root Mean Square Error of Approximation (RMSEA = 0.012). Despite the inherent limitations of GFI and AGFI due to their sensitivity to sample size, additional fit indices were considered for a comprehensive evaluation. The average chi-square ratio ($\chi 2/df = 1.027$) was well below the acceptable threshold of 3.0, reinforcing the model's good fit. Incremental fit indices, such as the Tucker Lewis Index (TLI = 0.898) and Comparative Fit Index (CFI = 0.910), further supported the adequacy of the model. Collectively, these fit indices (RMSEA = 0.012, GFI = 0.904, AGFI = 0.881, $\chi 2/df = 1.027$, CFI = 0.910, and TLI = 0.898) indicate a well-fitting measurement model, affirming the model's validity (Hair, 2011). The graphic representation of the CFA is illustrated in figure 3.

Figure 3

Measurement model of impact of FinTech adoption on sustainability performance with green finance and green innovation as mediating variables



Structural Model or Path Analysis

Figure 4 represents the shift in research focus from exploring the connections between hidden concepts and observable phenomena to analyzing the nature and intensity of these relationships. This transition reflects the study's progression from understanding measurement methodologies to investigating interrelationships among concepts. The structural model tests the five hypotheses as postulated above. These findings are shown in Table 10 which explains the relationships suggested by theoretical frameworks in understanding the interrelation of these factors in real-world contexts.

Table 10

SEM Path Analysis

Structural Path			Estimate	SRWa
Sustainability Performance	←	FinTech Adoption	0.298*** (0.001)	0.342
Green Finance	←	FinTech Adoption	1.701*** (0.001)	0.393

Green Innovation	←	FinTech Adoption	-0.911** (0.006)	-0.499
Sustainability Performance	←	Green Finance	0.081*** (0.001)	0.404
Sustainability Performance	←	Green Innovation	0.047* (0.057)	0.099

Squared Multiple Correlation

Sustainability Performance (γ2=0.349)
Green Finance(γ2=0.154)
Green Innovation (γ2=0.249)

Model Fit Measures

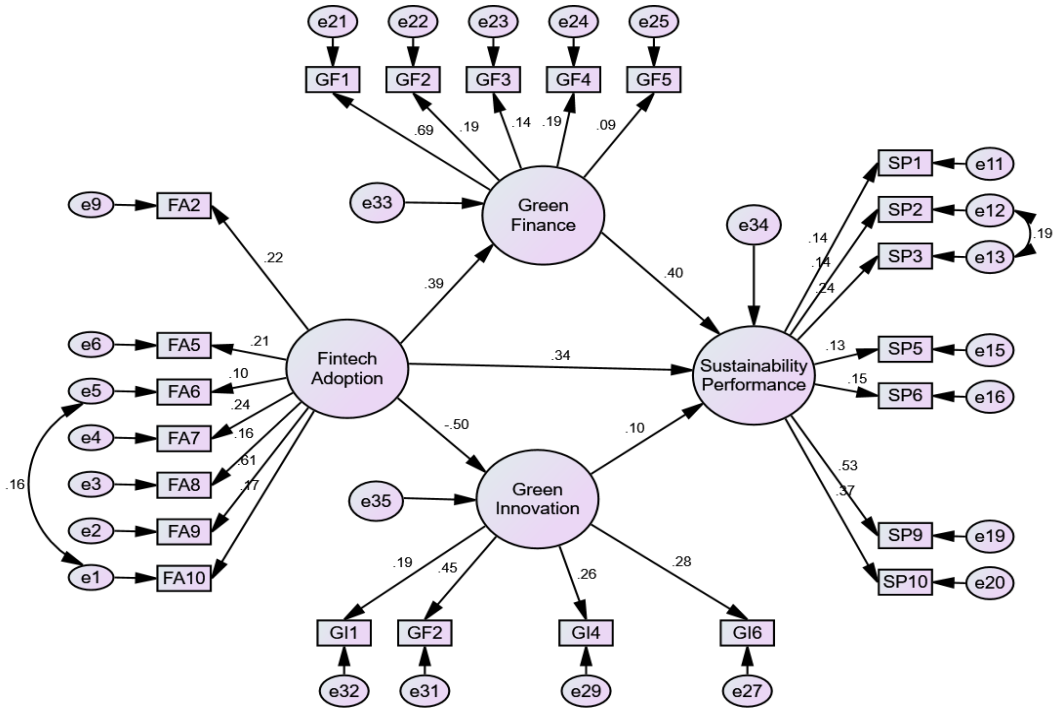
Chi-square = 229.406 (df=223)
CMIN/DF=1.029, CFI=0.903, RMSEA=0.013, TLI=0.89, GFI=0.903, AGFI=0.88
aSRW = Standardized regression weights*** p<0.001, **p<0.01, *p<0.1
Source: Field Survey, 2024 and authors' calculation

The hypothesis testing results, as detailed in Table 10, indicate significant relationships among the studied variables. FinTech adoption has a positive impact on sustainability performance (Estimate = 0.298, SRW = 0.342, $p < 0.001$). This may be because FinTech solutions improve operational efficiency and reduce environmental impact through digital processes, leading to higher sustainability performance. FinTech adoption also positively influences green finance (Estimate = 1.701, SRW = 0.393, $p < 0.001$), likely due to the enabling of eco-friendly financial products and services, which attract environmentally aware consumers and investors. However, FinTech adoption negatively impacts green innovation (Estimate = -0.911, SRW = -0.499, $p < 0.01$). This could be attributed to the potential focus on short-term financial gains and technological adoption over long-term innovation in green practices. Moreover, green finance positively influences sustainability performance (Estimate = 0.081, SRW = 0.404, $p < 0.001$). This relationship may exist because green finance provides the necessary funding for sustainable projects, thus directly enhancing the environmental and social performance of financial institutions. The impact of green innovation on sustainability performance is marginally significant (Estimate = 0.047, SRW = 0.099, $p < 0.1$), which might be due to the early stages of green innovation initiatives where the tangible benefits on sustainability performance are not yet fully realized. The model fit indices suggest a good fit of the structural model to the data. The chi-square value is 229.406 with 223 degrees of freedom, resulting in a CMIN/DF ratio of 1.029, which is

well below the threshold of 3.0, indicating an acceptable model fit. Additional fit indices further support this conclusion: the Comparative Fit Index (CFI) is 0.903, the Root Mean Square Error of Approximation (RMSEA) is 0.013, the Tucker-Lewis Index (TLI) is 0.89, the Goodness of Fit Index (GFI) is 0.903, and the Adjusted Goodness of Fit Index (AGFI) is 0.88. These indices collectively confirm the model's robustness in explaining the data. The squared multiple correlations reveal that FinTech adoption significantly impacts various dependent variables, explaining 34.9% of the variance in sustainability performance ($\gamma^2 = 0.349$), 15.4% in green finance ($\gamma^2 = 0.154$), and 24.9% in green innovation ($\gamma^2 = 0.249$). This indicates that FinTech adoption plays a crucial role in improving sustainability performance by enhancing operational efficiencies and reducing waste. It also significantly influences green finance by facilitating access to eco-friendly financial products and services. The impact on green innovation, though substantial, is complex, reflecting both the integration of digital technologies in existing processes and the potential challenges in developing entirely new green solutions. The graphic representation of the Path analysis is illustrated in figure 4.

Figure 4

SEM Path analysis of impact of FinTech adoption on sustainability performance with green finance and green innovation as mediating variables



Effect of Green Finance in the relationship of FinTech Adoption and Sustainability Performance

Mediation analysis was conducted to examine the mediating role of Green Finance (GF) in the relationship between FinTech Adoption (FA) and Sustainability Performance (SP). The hypothesis used for showing the mediation of green finance is as below:

H6: Green finance mediates the relationship between FinTech adoption and sustainability performance

The result of mediating analysis is tabulated in the following table:

Table 11

Mediating effect of green finance in the relationship of FinTech adoption and sustainability performance

Effect	Path	Estimate	SE	Lower	Upper	Z	p	% Mediation
	FA →							
Indirect	GF→ SP	0.010	0.011	-0.011	0.03	0.943	0.346	8.7
Direct	FA →SP	0.112	0.069	-0.024	0.249	1.608	0.108	91.3
Total	FA→SP	0.123	0.070	-0.014	0.261	1.75	0.08	100

The results (see table 11) indicate that the total effect of FinTech adoption on sustainability performance was statistically significant at 10 percent level of significance (H6: $\beta = 0.123$, SE = 0.070, Z = 1.75, $p = 0.08$. When considering green finance as a mediator, the direct effect of FinTech adoption on sustainability performance remained significant ($\beta = 0.112$, SE = 0.069, Z = 1.608, $p = 0.108$). Moreover, the indirect effect of FinTech adoption on sustainability performance through green finance was not statistically significant ($\beta = 0.010$, SE = 0.011, Z = 0.943, $p = 0.346$), with a 95% confidence interval ranging from -0.011 to 0.03. This suggests that the mediation path through green finance does not significantly explain the relationship between FinTech adoption and sustainability performance. Overall, while the direct effect of FinTech adoption on sustainability performance was substantial (91.3%), indicating that most of the relationship is direct, the mediation analysis indicates a small and nonsignificant indirect effect through green finance (8.7%). Therefore, green finance does not significantly mediate the relationship between FinTech adoption and sustainability Performance in this study.

Effect of Green Innovation in the relationship of FinTech Adoption and Sustainability Performance

Mediation analysis was conducted to examine the mediating role of Green Innovation (GI) in the relationship between FinTech Adoption (FA) and Sustainability Performance (SP). The hypothesis used for showing the mediation of green finance is as below:

H7: Green innovation mediates the relationship between FinTech adoption and sustainability performance

The result of mediating analysis is tabulated in table 12.

Table 12

Mediating effect of green innovation in the relationship of FinTech adoption and sustainability performance

Effect	Path	Estimate	SE	Lower	Upper	Z	P	% Mediation
	FA → GI	0.005	0.008	-0.011	0.021	0.619	0.536	4.24
Indirect	→ SP							
Direct	FA → SP	0.118	0.070	-0.019	0.255	1.684	0.092	95.76
Total	FA → SP	0.123	0.070	-0.014	0.261	1.75	0.08	100

The results (see Table 12) indicate that the total effect of FinTech adoption on sustainability performance was statistically significant at 10 percent level of significance (H7: $\beta = 0.123$, SE = 0.070, Z = 1.75, p = 0.08. When considering green innovation as a mediator, the direct effect of FinTech adoption on sustainability performance remained significant at 10 percent level of significance ($\beta = 0.118$, SE = 0.070, Z = 1.684, p = 0.092). Moreover, the indirect effect of FinTech adoption on sustainability performance through green innovation was not statistically significant ($\beta = 0.005$, SE = 0.008, Z = 0.619, p = 0.536), with a 95% confidence interval ranging from -0.011 to 0.021. This suggests that the mediation path through green innovation does not significantly explain the relationship between FinTech adoption and sustainability performance. Overall, while the direct effect of FinTech adoption on sustainability performance was substantial (95.76%), indicating that most of the relationship is direct, the mediation analysis indicates a small and nonsignificant indirect effect through green innovation (4.24%). Therefore, green innovation does not significantly mediate the relationship between FinTech adoption and sustainability performance in this study.

Discussion

The primary objective of this research was to examine the impact of FinTech adoption on the sustainability performance of financial institutions in Nepal, with particular attention to the mediating roles of green finance and green innovation. The findings represent that FinTech adoption positively impacts sustainability performance and green finance, but negatively influences green innovation. The positive relationship between FinTech adoption and sustainability performance is supported by Shah (2016), who found that FinTech solutions improve operational efficiency and reduce environmental impact through digital processes. This match with the view that technological advancements in the financial sector can lead to improved sustainability outcomes (Aryal et al., 2022). Similarly, Bisht et al. (2022) emphasized that

digitalization and FinTech improve accessibility and efficiency, contributing to the overall competitiveness and sustainability of financial institutions. In terms of green finance, the research findings determine a positive impact of FinTech adoption, which is consistent with the results of Siddik et al. (2023). They emphasized that FinTech allows eco-friendly financial products and services, attracting environmentally aware consumers and investors. This finding is also supported by Cai and Song (2022), who proved that firms globally are increasingly aware of their long-term environmental and social impacts, with green finance playing a critical role in sustainable business practices. However, the negative impact of FinTech adoption on green innovation contrasts with some existing literature. While this research suggests that FinTech may prioritize short-term financial gains over long-term innovation in green practices, Arner et al. (2020) proposed that FinTech can drive green innovation by offering new solutions for environmental challenges. This difference might be due to the early stages of green innovation initiatives in Nepal, where the tangible benefits on sustainability performance are not yet fully realized.

The mediation analysis highlighted that neither green finance nor green innovation significantly mediate the relationship between FinTech adoption and sustainability performance. This result contrasts with the findings of Yan et al. (2022), who suggested that green finance and green innovation could play significant mediating roles in enhancing sustainability performance through FinTech adoption. The lack of significant mediation in this study may be attributed to the unique socioeconomic and environmental conditions in Nepal, as highlighted by Niraula and Adhikari (2019). Additionally, the demographic analysis of our respondents showed a higher engagement in FinTech services among younger, more educated, and higher-income individuals. This is in line with Devkota et al. (2021), who found that digital wallets, mobile banking, and online payment methods are particularly popular among the youth and in urban areas of Nepal. In general, this study highlights the difficulty of integrating FinTech and sustainability in the financial sector. While FinTech adoption can enhance operational efficiency and support green finance, its impact on green innovation requires further investigation. Addressing these research gaps is essential for optimizing FinTech benefits and mitigating negative impacts on sustainability performance (Gautam & Devkota, 2021). So, it is critical to address this issue so that policymakers and financial institutions can align technological advancements with sustainable financial practices, thereby contributing positively to Nepal's unique socioeconomic and environmental context.

Conclusion

This study explored the essential role of FinTech in enhancing the sustainability performance of financial institutions in Nepal. FinTech adoption has clear benefits in

terms of operational efficiency and green finance facilitation but its impact on green innovation is unexpected and require further investigation. The non-significant mediation effects of green finance and green innovation suggest that the direct effects of FinTech adoption are more significant. Therefore, financial institutions should focus on holistic strategies that can incorporate both the technological advancements and sustainability practices. The cooperation between policymakers and financial institutions can leverage the contribution of FinTech innovations to the larger sustainability goals. However, future researches are needed for exploring other factors that might influence such relationship and investigating how integrated approaches can better align with FinTech adoption and sustainable performance goals.

References

Ahmad, M., Ahmed, Z., Bai, Y., Qiao, G., Popp, J., & Oláh, J. (2022). Financial Inclusion, Technological Innovations, and Environmental Quality: Analyzing the Role of Green Openness. *Frontiers in Environmental Science, 10*. https://doi.org/10.3389/fenvs.2022.851263

Arner, D. W., Buckley, R. P., Zetzsche, D. A., & Veidt, R. (2020). Sustainability, FinTech and Financial Inclusion. *European Business Organization Law Review, 21*(1), 7–35. https://doi.org/10.1007/s40804-020-00183-y

Aryal, A., Dhakal, R. C., & Khanal, K. (2022). Sustainable Green Finance Practices and Application in Commercial Banks: A Phenomenological Study. *Global Journal of Management and Business Research*, 31–36. DWT. https://doi.org/10.34257/gjmbrbvol22is5pg31

Belgacem, S. B., Adam, N. A., Khatoon, G., & Pawar, P. S. (2023). Do green finance, low-carbon energy transition, and economic growth help in environmental investment? Empirical evidence from emerging economies in Asia. *Geological Journal, 58*(9), 3259–3267. Portico. https://doi.org/10.1002/gj.4712

Benzidia, S., Makaoui, N., & Bentahar, O. (2021). The impact of big data analytics and artificial intelligence on green supply chain process integration and hospital environmental performance. *Technological Forecasting and Social Change, 165*, 120557. https://doi.org/10.1016/j.techfore.2020.120557

Bisht, D., Singh, R., Gehlot, A., Akram, S. V., Singh, A., Montero, E. C., ... & Twala, B. (2022). Imperative role of integrating digitalization in the firm's finance: A technological perspective. *Electronics, 11*(19), 3252. https://doi.org/10.3390/electronics11193252

Cai, X., & Song, X. (2022). The nexus between digital finance and carbon emissions:

Evidence from China. *Frontiers in Psychology, 13*. https://doi.org/10.3389/fpsyg.2022.997692

Calisir, F., & Gumussoy, C. (2008). Internet banking versus other banking channels: Young consumers' view. *Int. J. Inf. Manag., 28*, 215-221. https://doi.org/10.1016/j.ijinfomgt.2008.02.009.

Chaulagain, R. P. (2015). Financial Literacy for Increasing Sustainable Access to Finance in Nepal. *NRB Economic Review, 27*(2), 35–52. https://doi.org/10.3126/nrber.v27i2.52558

Chueca Vergara, C., & Ferruz Agudo, L. (2021). FinTech and Sustainability: Do They Affect Each Other? *Sustainability, 13*(13), 7012. https://doi.org/10.3390/su13137012

Dangelico, R., & Pujari, D. (2010). Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability. *Journal of Business Ethics, 95*, 471-486. https://doi.org/10.1007/S10551-010-0434-0.

Devkota, S. R. (2007). Socio-economic development in Nepal: Past mistakes and future possibilities. *South Asia Economic Journal, 8*(2), 285-315. https://doi.org/10.1177/139156140700800206

Devkota, N., Paudel, U. R., & Khanal, G. (2021). Is Current Understanding Adequate for Green Banking Practices in Nepal. *Advances in Finance, Accounting, and Economics*, 84–98. https://doi.org/10.4018/978-1-7998-7967-1.ch006

Gautam, B. P. (2014). Role of Financial Development in Economic Growth of Nepal: An Empirical Analysis. *NRB Economic Review, 27*(1), 1–16.

Gautam, S., & Devkota, S. (2021). Study on internet banking services of commercial banks in Nepal. *Journal of Business and Social Sciences, 3*(1), 111-120. https://doi.org/10.3126/jbss.v3i1.40859

Hu, K., Raghutla, C., Chittedi, K. R., Zhang, R., & Koondhar, M. A. (2021). The effect of energy resources on economic growth and carbon emissions: A way forward to carbon neutrality in an emerging economy. *Journal of Environmental Management, 298*, 113448. https://doi.org/10.1016/j.jenvman.2021.113448

Hu, W., & Li, X. (2023). Financial Technology Development and Green Total Factor Productivity. *Sustainability, 15*(13), 10309. https://doi.org/10.3390/su151310309

Khan, S., Akbar, A., Nasim, I., Hedvičáková, M., & Bashir, F. (2022). Green finance development and environmental sustainability: A panel data analysis. *Frontiers in Environmental Science, 10*. https://doi.org/10.3389/fenvs.2022.1039705

Li, L., Msaad, H., Sun, H., Tan, M. X., Lu, Y., & Lau, A. K. W. (2020). Green Innovation and Business Sustainability: New Evidence from Energy Intensive Industry in China. *International Journal of Environmental Research and Public Health, 17*(21), 7826. https://doi.org/10.3390/ijerph17217826

Lee, K.-H., & Min, B. (2015). Green R&D for eco-innovation and its impact on carbon emissions and firm performance. *Journal of Cleaner Production, 108*, 534–542. https://doi.org/10.1016/j.jclepro.2015.05.114

Moosa, I. (2022). *The benefits and costs of fintech. Fintech*, 81–104. https://doi.org/10.4337/9781802206340.00012

Muganyi, T., Yan, L., & Sun, H. (2021). Green finance, FinTech and environmental protection: Evidence from China. *Environmental Science and Ecotechnology, 7*, 100107. https://doi.org/10.1016/j.ese.2021.100107

Nangin, M. A., Barus, I. R. G., & Wahyoedi, S. (2020). The Effects of Perceived Ease of Use, Security, and Promotion on Trust and Its Implications on FinTech Adoption. *Journal of Consumer Sciences, 5*(2), 124–138. https://doi.org/10.29244/jcs.5.2.124-138

Nassiry, D. (2019). The Role of FinTech in Unlocking Green Finance. *Handbook of Green Finance*, 1–22. https://doi.org/10.1007/978-981-10-8710-3_27-1

Nguyen Dang, H.-A., Khan, A., Doan, A.-T., & Ibbett, N. (2021). The Social Impact of Green Innovation: Towards a Conceptual Framework. *International Journal of Public Administration, 45*(5), 399–411. https://doi.org/10.1080/01900692.2021.1913747

Niraula, A., & Adhikari, S. (2019). Examining Digital Finance Service as an Instrument for Financial Inclusion in Nepal. *Economic Review of Nepal, 2*(1), 212-227. https://doi.org/10.3126/ern.v2i1.53135

Ortiz-de-Mandojana, N., & Bansal, P. (2016). The long-term benefits of organizational resilience through sustainable business practices. *Southern Medical Journal, 37*, 1615-1631. https://doi.org/10.1002/SMJ.2410.

Pant, B. (2016). Financial inclusion in Nepal: Policy review and prescriptions. *NRB Economic Review, 28*(2), 1-18. https://doi.org/10.3126/nrber.v28i2.52531

Park, A., & Li, H. (2021). The Effect of Blockchain Technology on Supply Chain Sustainability Performances. *Sustainability, 13*(4), 1726. https://doi.org/10.3390/su13041726

Shah, K. K. (2016). Electronic Banking: Its Use and Challenge in Nepal. *Academic*

Voices: A Multidisciplinary Journal, 5, 9–15. https://doi.org/10.3126/av.v5i0.15845

Shahzad, M., Qu, Y., Zafar, A. U., Rehman, S. U., & Islam, T. (2020). Exploring the influence of knowledge management process on corporate sustainable performance through green innovation. *Journal of Knowledge Management, 24*(9), 2079–2106. https://doi.org/10.1108/jkm-11-2019-0624

Siddik, A. B., Yong, L., & Rahman, M. N. (2023). The role of FinTech in circular economy practices to improve sustainability performance: a two-staged SEM-ANN approach. *Environmental Science and Pollution Research, 30*(49), 107465–107486. https://doi.org/10.1007/s11356-023-25576-7

Singhvi, S., & Dadhich, M. (2023). FinTech Revolution and Future of Sustainable Banking: Opportunities and Risks Analysis. *International Journal of Management and Development Studies, 12*(04), 12-21. https://doi.org/10.53983/ijmds.v12n04.003

Sorenson, O., Assenova, V., Li, G.-C., Boada, J., & Fleming, L. (2016). Expand innovation finance via crowdfunding. *Science, 354*(6319), 1526–1528. https://doi.org/10.1126/science.aaf6989

Su, L., & Swanson, S. (2019). Perceived corporate social responsibility's impact on the well-being and supportive green behaviors of hotel employees: The mediating role of the employee-corporate relationship. *Tourism Management*. https://doi.org/10.1016/J.TOURMAN.2019.01.009

Wang, Z., Shahid, M. S., Binh An, N., Shahzad, M., & Abdul-Samad, Z. (2022). Does green finance facilitate firms in achieving corporate social responsibility goals? *Economic Research-Ekonomska Istraživanja, 35*(1), 5400–5419. https://doi.org/10.1080/1331677x.2022.2027259

Wang, Q.-J., Wang, H.-J., & Chang, C.-P. (2022). Environmental performance, green finance and green innovation: What's the long-run relationships among variables? *Energy Economics, 110*, 106004. https://doi.org/10.1016/j.eneco.2022.106004

Wang, Y., Xiuping, S., & Zhang, Q. (2021). Can FinTech improve the efficiency of commercial banks? —An analysis based on big data. *Research in International Business and Finance, 55*, 101338. https://doi.org/10.1016/j.ribaf.2020.101338

Xu, H., Mei, Q., Shahzad, F., Liu, S., Long, X., & Zhang, J. (2020). Untangling the Impact of Green Finance on the Enterprise Green Performance: A Meta-Analytic Approach. *Sustainability, 12*(21), 9085. https://doi.org/10.3390/su12219085

Yan, C., Siddik, A. B., Yong, L., Dong, Q., Zheng, G.-W., & Rahman, M. N. (2022). A Two-Staged SEM-Artificial Neural Network Approach to analyze the impact of

FinTech adoption on the sustainability performance of banking firms: The mediating effect of green finance and innovation. *Systems, 10*(5), 148. https://doi.org/10.3390/systems10050148

Zhang, Y. (2023). Impact of green finance and environmental protection on green economic recovery in South Asian economies: mediating role of FinTech. *Economic Change and Restructuring, 56*(3), 2069–2086. https://doi.org/10.1007/s10644-023-09500-0

Appendix: Operationalization of variables

S. n	Symbol	Statement
1	FA1	FinTech solutions enhance efficiency in financial operations.
2	FA2	FinTech solutions are easy to use.
3	FA3	FinTech solutions enable better financial outcomes.
4	FA4	FinTech solutions require little mental effort.
5	FA5	The opinions of colleagues or peers influence the decision to adopt FinTech solutions.
6	FA6	The necessary organizational infrastructure supports FinTech adoption.
7	FA7	FinTech solutions make managing finances more enjoyable.
8	FA8	FinTech solutions have become a routine part of financial management.
9	FA9	The benefits of using FinTech solutions outweigh their costs.
10	FA10	There is an intention to use FinTech solutions in financial activities.
11	SP1	FinTech adoption has reduced the carbon footprint and promoted eco-friendliness.
12	SP2	FinTech adoption has reduced reliance on paper through digital processes.
13	SP3	FinTech adoption has enabled reaching underserved communities, promoting financial inclusion.
14	SP4	FinTech investments support education, healthcare, and job creation.
15	SP5	FinTech adoption has improved transparency in ESG reporting.
16	SP6	FinTech adoption has enhanced risk management for better security and privacy.
17	SP7	FinTech adoption has increased efficiency and reduced costs, supporting long-term stability.
18	SP8	FinTech adoption ensures a financially sustainable future for institutions.

19	SP9	FinTech adoption demonstrates commitment to long-term value for customers and shareholders.
20	SP10	FinTech transparency builds trust and a positive reputation for institutions.
21	GF1	Green loans and bonds help customers choose financial services.
22	GF2	Green finance practices reduce carbon emissions.
23	GF3	Customers will pay more for eco-friendly financial products.
24	GF4	Public awareness of green finance boosts demand.
25	GF5	Green finance makes financial institutions stronger against climate risks.
26	GF6	Lower interest rates for eco-projects encourage green finance choices.
27	GI1	Nepal's financial institutions invest in green solutions.
28	GI2	FinTech boosts green innovations in finance.
29	GI3	Innovation in green financial products is key for success.
30	GI4	Working with tech companies helps foster green innovation.
31	GI5	FinTech helps create new financial products for environmental challenges.
32	GI6	Adapting to new technology improves green innovation in finance.