



The effect of Fintech adoption on green finance and environmental performance of banking institutions during the COVID-19 pandemic: the role of green innovation

Zheng Guang-Wen¹ · Abu Bakkar Siddik²

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Abstract

Despite the availability of substantial empirical evidence on the influence of green finance (GF) or green innovation (GI) on environmental performance (EP), only a few studies have attempted to examine the link between Fintech adoption (FA), GF, GI, and EP during the COVID-19 pandemic. Thus, by applying the structural equation modeling (SEM) approach to the data obtained from 302 banking staff in a developing economy (in this case, Bangladesh), this research work empirically examines the association between FA, GF, and EP, alongside the mediating role of GI. The empirical results indicated that FA significantly impacts GF, GI, and EP and that GF has a significant positive influence on GI and EP. Also, GI was observed to positively influence EP and partially mediate the relationship between FA, GF, and EP of banks. As one of the earliest studies to empirically investigate the relationships among these variables, these findings add to the existing scholarship on technological innovation, green finance, and environmental sustainability in the context of financial institutions in an emerging market during the pandemic. Moreover, the study demonstrates the significance of FA, GF, and GI in improving the EP of financial institutions and, ultimately, in ensuring the sustainable economic development of the country.

Keywords Fintech adoption · Green finance · Green innovation · Environmental performance · Banks · COVID-19

Introduction

Environmental sustainability has become a hot topic among researchers and practitioners in the financial sector in recent years, particularly in the aftermath of the COVID-19 pandemic (Raphael 2021), which affected the business processes and sustainability performance of banking institutions across the world (Siddik and Zheng 2021). Consequently, the banking industry has adopted

and implemented a variety of measures including the adoption of Fintech and GF to sustain their businesses and also enhance their EP. Despite the instability and uncertainty that COVID-19 brought to economies around the world, Fintech recorded a remarkable development, particularly in developing countries, as contactless payments became more widespread (C. Yan et al. 2021). Besides, Fintech and GF have been identified by policymakers, particularly in emerging economies, as a necessity toward the achievement of the Paris Agreement and the Sustainable Development Goals (SDGs) (Nassiry 2019). Financial institutions remain indispensable players in a country's mission to attain the SDGs. By adopting innovative technologies such as blockchain, green banking, and online banking (Nassiry, 2019) and sponsoring a number of eco-friendly projects, including renewable or alternative energy and green industry development, the banking industry contributes significantly to a nation's sustainability performance (Aker et al. 2018; Zheng et al. 2021a, b). However, it remains unclear how technological innovation and GF accelerate organizations' achievement of environmental sustainability during the pandemic. As such, this research

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✉ Abu Bakkar Siddik
ls190309@sust.edu.cn

Zheng Guang-Wen
zhengguangwen@sust.edu.cn

¹ School of Economics and Management, Shaanxi University of Science and Technology (SUST), Weiyang University Park, Weiyang District, Xi'an 710021, Shaanxi, China

² School of Management, University of Science and Technology of China (USTC), Jinzhai Road, Hefei 230026, China

focuses on investigating the determinants of EP of banking institutions in a developing country during the pandemic.

The issue of economic growth and environmental sustainability has been persisting over the years and has called for the adoption of holistic strategies such as technological innovation to ensure sustainable development (Awawdeh et al. 2022; Kraus et al. 2020; Ozturk et al. 2022). Examples of such innovation are Fintech and GF, both of which have gained popularity, particularly in the wake of the epidemic (Xie et al. 2021). Fintech can be defined as the incorporation of innovative technologies such as blockchain into financial services (Dorffleitner et al. 2017). In other words, it involves the application of technology innovation to deliver financial services and products to users (Dwivedi et al. 2021). Meanwhile, GF refers to financial investments in diverse eco-friendly projects that promote the environmental sustainability of organizations, thereby driving the nation's economic sustainability (Siddik and Zheng 2021). Financial technology such as blockchain can speed up capital flow toward a more sustainable economic innovation, while financial instruments such as GF have a notable positive impact on the environmental sustainability of organizations (Awawdeh et al. 2022; Nassiry 2019; Zhang et al. 2022). Another key determinant of the corporate sector's EP is the GI (Li et al. 2020; Zheng et al. 2021a, b), which is defined as technology advancements that serve to minimize anti-environmental activities such as air pollution, waste disposal, and the burning of fossil fuels (Kraus et al. 2020). During the pandemic, Fintech and GF promote the environmental sustainability of financial institutions by integrating eco-friendly innovations such as digital and mobile banking into their operations and financing series of pro-environmental initiatives, including renewable or alternative energy, waste management, and green industry development.

Recently, numerous studies have investigated the link between GF and corporate environmental outcomes (Awawdeh et al. 2022; Chen et al. 2022; Indriastuti and Chariri 2021; Zhang et al. 2022). Xu et al. (2020) discovered that GF has a considerable beneficial effect on corporate green initiatives, while Awawdeh et al. (2022) recognized technological advancement as a significant determinant of EP. Dwivedi et al. (2021) found that the banks' competitiveness and efficiency are influenced by FA. The positive association between GI and business outcomes including EP was also confirmed by Wang et al. (2021). Despite the numerous studies on the positive influence of GF and GI on a firm's EP, there is a dearth of academic inquiry into the link between FA, GF, GI, and EP from the perspective of financial institutions during the pandemic. Moreover, the existing studies on this link are marred with inconsistent findings (Chen et al. 2022). Therefore, the current research intends to bridge this void by investigating the relationship

between FA, GF, and EP in the banking industry during the pandemic and the indirect role of GI.

In attaining the aforementioned research objectives, the following research questions will be addressed: RQ1: Does FA influence the GF, GI, and EP of banks during the pandemic? RQ2: Does GI partially or completely mediate the relationship between FA, GF, and EP of the banking industry during the pandemic? The current research makes several theoretical and practical contributions. As an instance, this is a ground-breaking research that develops a comprehensive study framework to integrate FA, GF, GI, and EP in a single study. Furthermore, the study looks at the connection between FA, GF, and EP, with GI serving as a mediator. Also, the outcome of this study will provide banking executives of developing nations like Bangladesh with valuable insights on how to achieve long-term viability through FA and GF during and after crises, such as the pandemic. The rest of this work is arranged in the following manner: The "Literature review and hypotheses development" section explores the literature and elaborates on the hypotheses. The "Research methods" section shows the research approach, introduces the data, and describes the sample. The "Data analysis and results" section covers the main findings, and the "Discussion" section advances the discussion and conclusions. The final section discusses potential ramifications, limitations, and future research directions.

Literature review and hypotheses development

Fintech adoption and EP

Nowadays, Fintech is attracting the attention of experts as more and more people are desiring eco- and user-friendly goods and services. With the aid of Fintech, financial institutions are able to expedite their financial services. Fintech refers to the deployment of technology innovation for the delivery of financial services and products to users (Dwivedi et al. 2021). Adaba et al. (2019) and Karusala et al. (2019) highlighted that internet banking contributes significantly to socioeconomic resilience during the pandemic. Financial businesses have been transformed over the years due to the advancement of ICT, which allows for more efficient service delivery and better environmental performance (Yan et al. 2021). Furthermore, Li et al. (2022) emphasized that the function of financial depth should be expanded to achieve a sustainable environment. Previous literature has established technological innovation as a significant determinant of EP (Awawdeh et al. 2022). Similarly, Dwivedi et al. (2021) found that FA has a notable effect on the banks' efficiency and competitiveness. Furthermore, innovation emphasizes the development of products and the adoption of procedures

that promote environmental sustainability (Awawdeh et al. 2022). A recent study has established a link between technical innovation and environmental sustainability (Severo et al. 2019). The study also recommended that businesses should adopt environmentally friendly technology, as it helps to achieve overall EP. FA plays an important role in achieving banking institutions' environmental sustainability by incorporating eco-friendly technology into their operations during the pandemic. The flowchart of the literature review can be shown in Fig. 1. Thus, the study hypothesizes the following.

H₁: There is a significant and positive relation between FA and the EP of banking institutions during the pandemic.

Fintech adoption, green finance, and green innovation

The nexus between innovation and environmental sustainability has been extensively examined in the literature (Awawdeh et al. 2022). However, there are limited studies on the association of FA with GF and GI, particularly during the COVID-19 epidemic and from the viewpoint of emerging economies. Therefore, this study intends to address this void by establishing the links existent between these variables. Awawdeh et al. (2022) recently discovered a significant positive influence of GF and CSR on innovative technology and corporate EP during the pandemic. According to Peng and Zheng (2021), GF can boost energy efficiency by supporting the development of innovative energy technologies, which can help policymakers optimize energy structure and enhance sustainability. Fintech relies on GF technologies like artificial intelligence (AI), blockchain, the Internet of Things (IoT), and big data to actualize SDGs (Nassiry 2019).

Recent literature has demonstrated that Fintech innovation largely supports green economic growth through green investment and lending (Zhou et al. 2022). Similarly, Yan et al. (2022) reported a significant positive impact of FA on the GF and GI of banks in an emerging economy. Nevertheless, mixed findings have also been reported on the relationship between GF and GI (Wang et al. 2022a, b). In developing nations possessing lower levels of GF, a positive effect of GF on GI was observed. In contrast, an unfavorable effect of GF on GI was discovered in countries possessing higher levels of innovative technology or EP. Xiong and Sun (2022) further opined that the relationship between GF and GI is strengthened by green insurance and green structure (Xue et al. 2022). Hence, existing findings on the link between Fintech adoption, GF, and GI are inconclusive and thus require further scrutiny. Nevertheless, it can be argued that FA, GF, and GI are crucial in achieving an organization's environmental sustainability during the pandemic period. In view of the aforesaid, the following research hypotheses have been proposed.

H₂: There is a significant and positive association between FA and the GF of banking institutions during the pandemic.

H₃: There is a significant and positive association between FA and the GI of banking institutions during the pandemic.

H₄: There is a significant and positive association between GF and the GI of banking institutions during the pandemic.

Green finance and EP

The relationship between GF and a firm's EP has long been studied, with several pieces of evidence pointing toward the

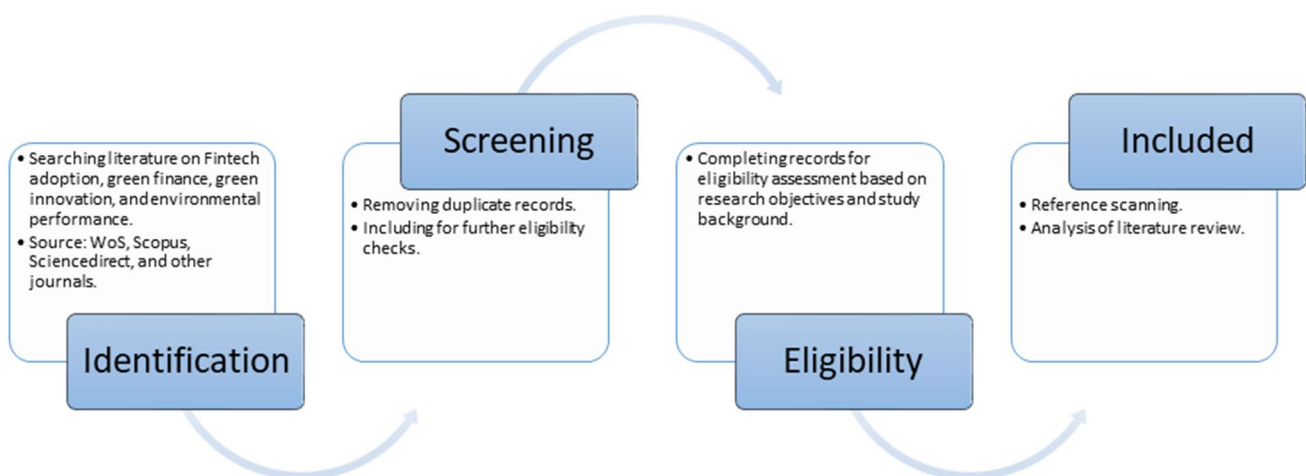


Fig. 1 Flowchart of literature review

presence of a positive association between the two variables. To put it simply, the greener the finance of a company, the better its EP. Hence, in line with Zhang et al. (2022), GF has been described in this article as the funding of different pro-environmental initiatives such as clean energy and technology to ensure better EP of banks. Recent literature has also confirmed that GF positively influences corporate EP (Awawdeh et al. 2022; Guang-Wen and Siddik 2022). Furthermore, Xu et al. (2020) also established the favorable influence of GF on enterprise green performance. Indriastuti and Chariri (2021) also indicated that green investment promotes better financial and sustainability performance of firms. Moreover, Alola and Ozturk (2021) proposed that while environmental sustainability is likely to be achieved at the highest level of income, it is likely to be at the expense of investment risk. The link between GF and the environmental outcomes of a firm is firmly established in the existing literature. In light of that, GF is expected to have a significant positive impact on the EP of banking institutions during the epidemic.

H₅: There is a significant and favorable association between GF and the EP of banking institutions during the pandemic.

Green innovation and EP

According to Kraus et al. (2020), GI is defined as technology advancements aimed at curtailing waste disposal, environmental deterioration, air pollution, energy consumption, and the burning of fossil fuels. In today's corporate sector, GI has been pivotal in preventing the negative consequences of climate change (Li et al. 2020; Zheng et al. 2021a, b). By reducing greenhouse gas emissions, lessening the strain on the environment, and promoting environmentally friendly production, green technology fosters new kinds of knowledge creation (Ali et al. 2021). Adebile et al. (2017) found that incorporation of GI into firms' environmental management strategy results in better EP. In addition, research has shown that GI considerably minimizes the negative impact of a firm's operation on the environment while simultaneously boosting its profits through better cost and waste control (Weng et al. 2015; Yan and Zhang 2021). In agreement with the report by H. Wang et al. (2021), Kraus et al. (2020) demonstrated that GI determines the EP of manufacturing firms. On the contrary, Edeh et al. (2020) found that tech innovation significantly enhanced trade flows. Various research on the GI-EP nexus have been undertaken to date, albeit with conflicting findings (Kraus et al. 2020). Therefore, this research seeks to validate the relationship between GI and EP in the banking industry during the COVID-19 epidemic. In view of the above-mentioned, the following research hypothesis has been developed.

H₆: There is a significant and positive association between GI and the EP of banking institutions during the pandemic.

The mediating role of GI

The previous explanation of the relationship between FA, GF, GI, and EP revealed that GF and FA greatly improve GI, which in turn enhances the EP of organizations. However, no prior study has investigated the association between FA, GF, and EP through the mediating variable of GI during the pandemic. Therefore, the current study fills this void by evaluating the link between these factors in the context of a developing market's financial sector. Furthermore, researchers have demonstrated that GI significantly influences EP (Ahmad et al. 2021; Kraus et al. 2020; H. Wang et al. 2021). Also, existing research has validated that GF positively influences GI (Wang et al. 2022a, b). Likewise, Kraus et al. (2020) found that GI acts as a mediator in the relationship between CSR and EP. Taken together, these results indicate the possible influence of GI on the link between FA, GF, and EP of the banks during the pandemic. Thus, the following research hypotheses have been proposed.

H₇: GI acts as a partial or full mediator in the link between FA and EP of banks during the pandemic.

H₈: GI partially or fully mediates the relationship between GF and EP of banks during the pandemic.

Research methods

Survey instrument development

Through literature review, scales were identified to evaluate the variables (FA, GF, GI, and EP) used in the study. The current study used structured questionnaires adapted from various previous studies to obtain the primary data required to assess the possible impact of FA on GF and EP alongside the mediating effect of GI during the COVID-19 pandemic. The structured questionnaire consists of two parts: The first section gathers the demographic information of respondents, and the second contains questions about the endogenous and exogenous factors utilized for the study. The responses were scored on a five-point Likert rating scale, where 1 represents "strongly disagree" and 5 denotes "strongly agree." To measure FA, seven items were adapted from earlier studies (Yan et al. 2021; Al Nawayseh, 2020; Hu et al. 2019). The FA scale measures a banker's perception of the influence of their firm's FA motives on GF, GI, and EP (e.g., "our bank already adopted mobile banking services or intends to continue using them in the future"). These items generated an alpha value of 0.842. Furthermore, a total of six items, which

were incorporated from the works of Zheng et al. (2021a, b) and (Zhang et al. 2022), were used to measure GF. The GF scale used different statements to measure GF (e.g., our bank focuses more on investment in pro-environmental projects like green energy, pollution prevention, and eco-friendly industry). The four-item measures for GI were culled from earlier works (Kraus et al. 2020; Tang et al. 2018). In this regard, participants may be asked to respond to questions like “our bank adopts eco-sustainable technology and offers remote customer support services.” Moreover, the EP scale was measured using seven items, which were drawn from the extant studies (Suganthi 2020; Kraus et al. 2020; Zhang et al. 2022). An example of these items includes FA, GF, and GI, promoting the reduction of greenhouse gas emissions in banking operations. These items generated a reliability value of 0.863. The study method is depicted graphically in Fig. 2.

Sampling and data collection

This current study has two main objectives: first, to establish whether FA influences the GF and EP of banks in developing countries like Bangladesh during the recent COVID-19 pandemic, and second, to investigate the mediating function of GI on the link between FA, GF, and EP. To actualize these objectives, private commercial banks (PCBs) operating in Bangladesh have been considered due to their important contribution to the adoption of Fintech, such as mobile banking (Khatun et al. 2021; Yan et al. 2021) and green financing (Siddik and Zheng 2021; Zheng et al. 2021a, b). Extant literature has also established that financial institutions play a crucial role in the sustainable economic development of a country through their investment in various green projects (Chen et al. 2022; Zheng et al. 2021a, b). Moreover, the Fintech industry in Bangladesh such as Bkash, a

subsidiary of Brac Bank Limited and leading provider of Mobile Financial Services (MFS), recorded a surge in the number of their service users during the pandemic (Khatun et al. 2021; Yan et al. 2021). This high adoption rate of mobile banking among Bangladeshis during the outbreak is advantageous to our study.

Using a structured questionnaire, the study obtained primary data from the bankers of PCBs located in Dhaka (the capital city of Bangladesh). These respondents were selected using a convenience sampling technique from July to November 2021. We gathered a total of 360 questionnaires, 58 of which were later eliminated owing to missing or incomplete values. Hence, the total sample size for the study was 302. Ahead of the actual survey, we conducted a pilot test among 25 randomly selected PCB workers to evaluate the quality and reliability of the questionnaire items. The background information of the participants are shown in Table 1.

Common method bias

The current study used a questionnaire survey to collect data on both independent and dependent variables from a single source. As a result, there is a chance of common method bias (CMB) occurrence in our dataset. According to Podsakoff and Organ (1986), CMB is a serious issue and is commonly related to self-reported data. Besides, it can also exaggerate a relationship that exists between measurement items (Conway and Lance 2010). During the data collection process, respondents must be assured that the information they provide is secure and will not be disclosed to a third party (Kraus et al. 2020). Harman’s single-factor technique was utilized in the study to calculate the CMB issue. A total variance value of less than 50% implies the absence

Fig. 2 Flowchart of research methods

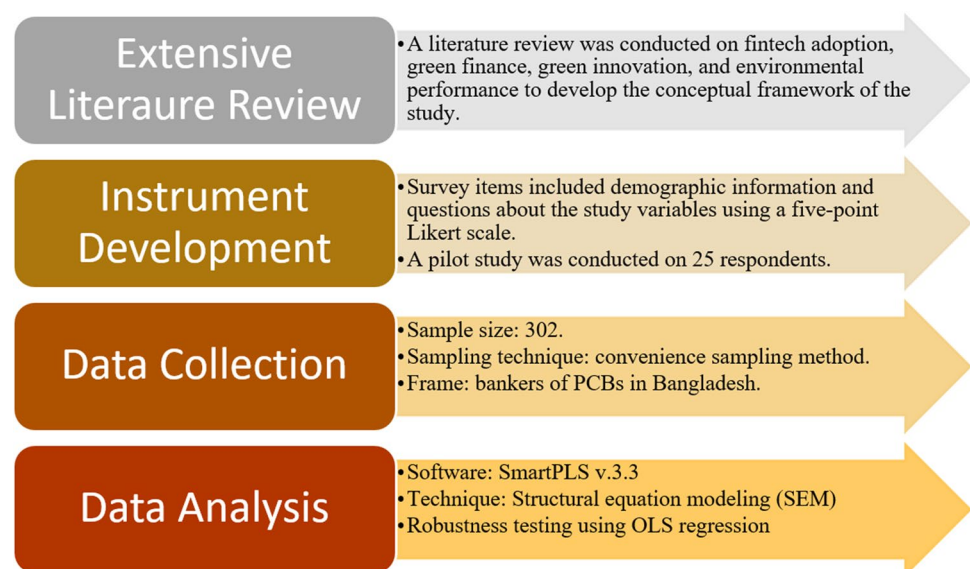


Table 1 The demographic profile of respondents

| Variables | Particular | Frequency | Percentage (%) |
|---------------------------|-------------------|-----------|----------------|
| Gender | Male | 248 | 82.1 |
| | Female | 54 | 17.9 |
| Age (years) | 18–30 | 72 | 22.9 |
| | 31–40 | 160 | 53.0 |
| | 41–50 | 54 | 17.9 |
| | Above 50 | 16 | 5.3 |
| Educational qualification | Undergraduate | 18 | 5.9 |
| | Postgraduate | 282 | 93.4 |
| | M.Phil or Ph.D | 2 | 0.7 |
| Job position | Manager | 31 | 10.3 |
| | Assistant Manager | 49 | 16.2 |
| | Principal Officer | 42 | 13.9 |
| | Officer | 94 | 31.1 |
| | Banking Assistant | 2 | 0.7 |
| | Banking Trainee | 1 | 0.3 |
| | Others | 83 | 27.5 |
| Working experience | Less than 1 year | 10 | 3.3 |
| | 1–3 years | 50 | 16.6 |
| | 3–6 years | 60 | 19.9 |
| | Above 6 years | 182 | 60.3 |

of a CMB, while a CMB value larger than 50% suggests otherwise. The empirical findings showed that a single variable explains 38.801% of the total variance, suggesting that CMB is not an issue in the data used in this study.

Data analysis and results

In line with Ringle et al. (2015), this study employed the SEM approach (via SmartPLS 3.3.3) to examine the association between FA, GF, and EP, alongside the mediating effect of GI. There are several benefits to using PLS-SEM. For example, while examining mediation, the PLS-SEM is considered better than regression in terms of executing estimations (Preacher and Hayes 2004). According to Chin (1998), the PLS-SEM strategy accounts for measurement error and provides a more accurate estimate of the mediation effect. Furthermore, the literature has shown that PLS-based SEM is more suitable for complex and simple experimental research because SmartPLS eliminates the requirement to validate the normalcy assumption (Hair Jr et al. 2016). The PLS-SEM includes both measurement and structural models. The relationship between the measured and latent variables is established in the measurement or outer model, whereas the connections between the latent constructs are investigated in the structural or inner model. A bootstrap procedure based on 5000 subsamples was also utilized to

investigate the study hypotheses. The measurement and structural model outputs are addressed further below.

Measurement of inner model

To ascertain the validity of the variables utilized in this study, reliability and validity tests were conducted. The outcomes of the measurement model, i.e., the construct's reliability and validity, are shown in Table 2. The empirical results indicated that the lowest and highest individual factor loadings are 0.663 and 0.833, respectively, both of which exceed the suggested value of 0.50 (Hair et al. 2012) (Fig. 3), thus affirming the reliability of the individual item used in this study. We have also calculated Cronbach's alpha (CA) and composite reliability (CR) values to verify the internal reliability of the constructs, and the values must be higher than 0.60 to be considered satisfactory (Hair et al. 2012). The results in Table 2 showed that all the variables had CA and CR values higher than the recommended value of 0.60; therefore, the study model had satisfactory internal consistency (Bagozzi and Yi 1988). The convergent validity of study variables was investigated using the average variance explained (AVE) value, and the empirical findings (see Table 2) indicated AVE values ranging from 0.515 to 0.626, which exceed the threshold value of 0.50 (Hair et al. 2012). As a result, it can be assumed that the study variables satisfy the convergent validity, according to the criteria of Hair et al. (2012).

Furthermore, to assess the discriminant validity of the study variables, we have utilized two popular approaches: the Fornell-Larcker criterion and the Heterotrait-Monotrait (HTMT) correlation ratio. The outcomes are reported in Table 3 and indicated that the correlations between each set of constructs do not exceed the square root of their AVE. Besides, all the variables had HTMT values less than 0.85, indicating that the studied variables attained satisfactory discriminant validity (Fornell and Larcker 1981; Hair et al. 2010; Henseler et al. 2015). The study further assessed the study variables for multicollinearity problems via the variance inflation factor (VIF). To confirm the absence of multicollinearity issues among the variables, Hair et al. (2012) suggested that the VIF value should be below 5. The empirical results (see Table 3) showed that the VIF value is less than 5, further confirming the discriminant validity of the variables.

Predictive relevance and effect size

Based on the previous studies, Q^2 was calculated in this study using the blindfolding procedure to evaluate whether or not the PLS path model has a predictive relevance (Geisser 1974; Stone, 1974; Hair et al. 2019). According to Wynne W Chin (2001), the Q^2 value should be greater than

Table 2 Outcomes of the measurement model

| Variables | Items | Factor loadings | CA | CR | AVE | R ² |
|--------------------------------|-----------------------|-----------------|-------|-------|-------|----------------|
| Environmental performance (EP) | EP1 | 0.734 | 0.863 | 0.897 | 0.594 | 0.451 |
| | EP2 | 0.781 | | | | |
| | EP3 | 0.833 | | | | |
| | EP4 | 0.809 | | | | |
| | EP6 | 0.766 | | | | |
| | EP7 | 0.696 | | | | |
| | Fintech adoption (FA) | FA1 | | | | |
| FA2 | | 0.663 | | | | |
| FA3 | | 0.739 | | | | |
| FA4 | | 0.799 | | | | |
| FA5 | | 0.68 | | | | |
| FA6 | | 0.762 | | | | |
| FA7 | | 0.666 | | | | |
| Green finance (GF) | GF1 | 0.745 | 0.878 | 0.909 | 0.626 | 0.316 |
| | GF2 | 0.837 | | | | |
| | GF3 | 0.879 | | | | |
| | GF4 | 0.816 | | | | |
| | GF5 | 0.788 | | | | |
| | GF6 | 0.666 | | | | |
| Green innovation (GI) | GI1 | 0.816 | 0.701 | 0.830 | 0.620 | 0.343 |
| | GI2 | 0.793 | | | | |
| | GI4 | 0.751 | | | | |

CA, Cronbach's alpha; CR, composite reliability; AVE, average variance explained

zero (0). On the other hand, Cohen (2013) suggested that Q^2 value greater than 0.02, 0.15, and 0.35 signifies small, medium, and large predictive relevance, respectively. The Q^2 values for GF (0.186), GI (0.204), and EP (0.261) were higher than the suggested value of 0.15 (Cohen 2013), indicating the presence of a medium predictive relevance effect. Hence, the conceptual framework used in this study can predict endogenous constructs (Cohen 2013). According to Henseler et al. (2009), it is recommended to calculate the effect size (f^2) of each path coefficient in the structural model, and f^2 values exceeding 0.35, 0.15, and 0.02 are considered large, moderate, and small, respectively (Cohen, 2001). The f^2 value indicates whether an independent construct has a notable effect on a dependent construct (Götz et al. 2010). The empirical findings revealed that FA has a small influence on EP (0.06) and GI (0.097), but a large influence on GF (0.462). On the other hand, GF has a smaller effect size on EP (0.085) and GI (0.133), similar to the effect of GI on EP (0.108) (Table 4).

Structural model and test of research hypotheses

Following the execution of the measurement model described in the preceding section, the study employed SEM and path analysis to validate the estimated research hypotheses. The study computed the t -value and p -value to

test the stated hypotheses, and if the t -value > 1.96 or the p -value < 0.05 , the proposed hypotheses are supported and vice versa. The structural model evaluation revealed that the model has moderate-to-large explanatory power, explaining 45.1 percent of the variation in EP, 31.6 percent of the variation in GF, and 34.3 percent of the variation in green innovation. Hence, it can be stated that the theoretical model used in this study has a very strong explanatory power (Chin 1998). The outcomes of the research hypotheses are presented in Table 5 and showed that FA has a significant impact on EP ($\beta = 0.230$, p -value = 0.000), GF ($\beta = 0.562$, $p = 0.000$), and GI ($\beta = 0.306$, $p = 0.000$), implying that Hypotheses 1–3 are supported. Also, GF has a significant positive effect on GI ($\beta = 0.357$, $p = 0.000$) and EP ($\beta = 0.278$, $p = 0.000$). Thus, Hypotheses 4 and 5 are accepted. In agreement with Hypothesis 6, the empirical findings showed that GI significantly determines the EP, with a β -value of 0.301 and p -value of 0.000.

Moreover, the study used variance accounted for (VAF) to examine the mediation effect of GI between the study variables, i.e., FA, GF, and EP. According to Hair et al. (2010), there is no mediation if the VAF value is below 20%; a VAF value from 20 to 80% signifies a partial mediation, and a VAF value greater than 80% indicates a full mediation. The outcomes of the VAF are shown in Table 6 and indicated a mediating effect of 57.25%. This implies that GI has a partial mediation effect on the FA-EP

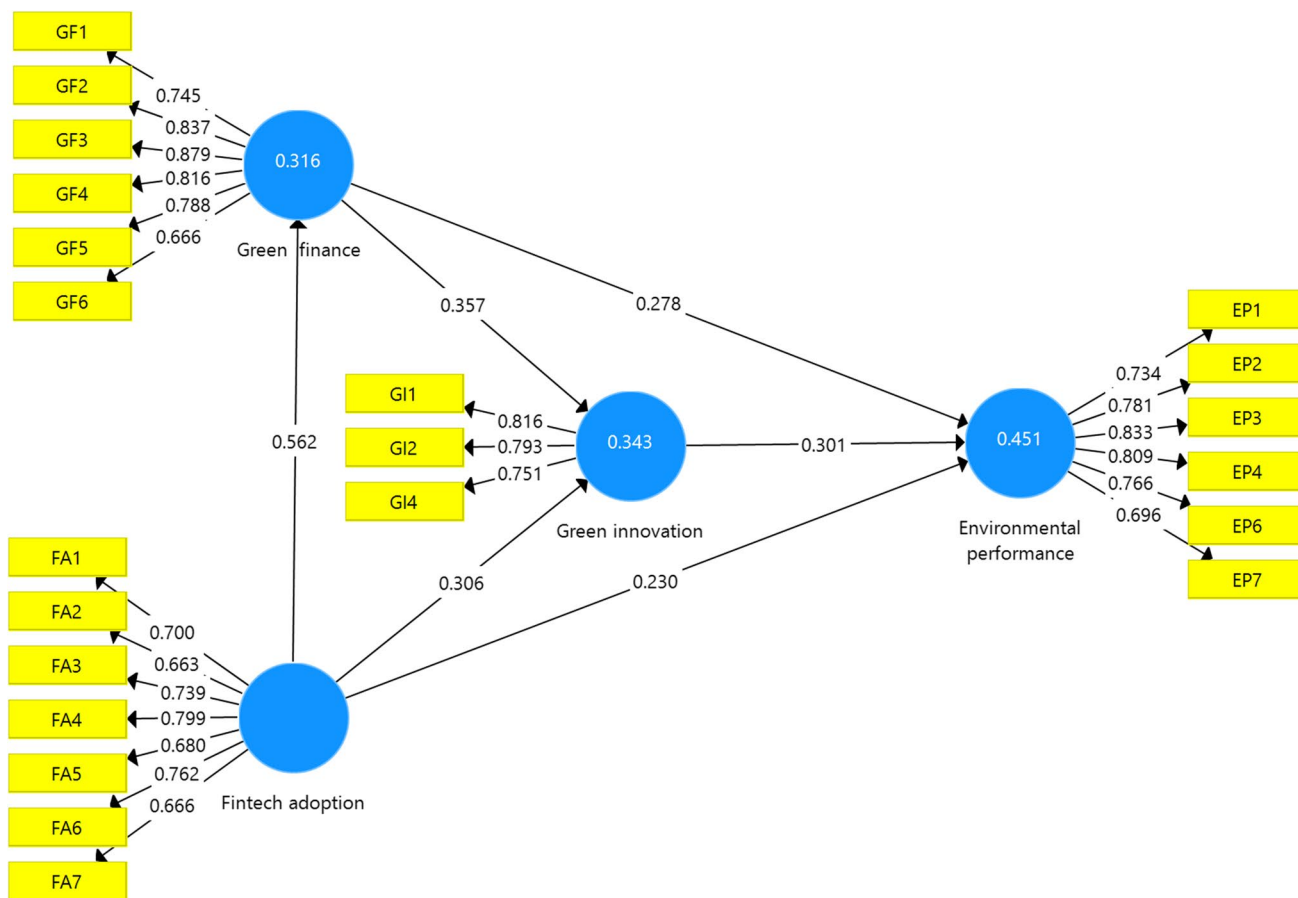


Fig. 3 Measurement model

Table 3 Discriminant validity

| Variables | EP | FA | GF | GI |
|---------------------------|--------------|--------------|--------------|--------------|
| Fornell-Larcker criterion | | | | |
| EP | 0.771 | | | |
| FA | 0.538 | 0.717 | | |
| GF | 0.566 | 0.562 | 0.791 | |
| GI | 0.564 | 0.506 | 0.529 | 0.787 |
| HTMT criterion | | | | |
| EP | | | | |
| FA | 0.624 | | | |
| GF | 0.646 | 0.649 | | |
| GI | 0.724 | 0.664 | 0.672 | |

the bold italic value indicates the square root of AVE

Table 4 Effect size of the model

| Variables | EP | GF | GI |
|-----------|-------|-------|-------|
| FA | 0.06 | 0.462 | 0.097 |
| GF | 0.085 | | 0.133 |
| GI | 0.108 | | |

association of banking institutions during the pandemic, thereby confirming Hypothesis 7. According to the findings, GI partially mediates the link between GF and EP, given the mediating effect of 35.55%. Hence, Hypothesis 8 is supported.

Robustness test

To assess the robustness of the findings, we have employed several techniques such as PLS-SEM and OLS regression models to examine the relationships among the study variables. Tables 5 and 7 present the findings of the PLS-SEM and OLS regression models. According to the results from both models, all hypotheses (including the mediation hypotheses) are supported. Hence, the robustness of the baseline model used in this study is confirmed.

Discussion

This paper endeavors to empirically assess whether FA influences the GF, GI, and EP of banks in developing markets like Bangladesh during the COVID-19 pandemic. It also looks into the possible role of GI in mediating

Table 5 Outputs of research hypotheses

| SL | Path coefficients | β -values | <i>t</i> -statistics | <i>p</i> -values | Results |
|----------------------------|-------------------|-----------------|----------------------|------------------|-------------------|
| H ₁ | FA—> EP | 0.230 | 5.019 | 0.000 | Accepted |
| H ₂ | FA—> GF | 0.562 | 7.216 | 0.000 | Accepted |
| H ₃ | FA—> GI | 0.306 | 5.275 | 0.000 | Accepted |
| H ₄ | GF—> GI | 0.357 | 5.607 | 0.000 | Accepted |
| H ₅ | GF—> EP | 0.278 | 4.413 | 0.000 | Accepted |
| H ₆ | GI—> EP | 0.301 | 5.519 | 0.000 | Accepted |
| Mediation analysis results | | | | | |
| H ₇ | FA—> GI-> EP | 0.308 | 3.813 | 0.001 | Partial mediation |
| H ₈ | GF—> GI-> EP | 0.107 | 3.933 | 0.000 | Partial mediation |

Table 6 VAF of the mediator variable of green innovation

| IV | DV | MV | IE | TE | VAF (%) |
|----|----|----|-------|-------|---------|
| FA | EP | GI | 0.308 | 0.538 | 57.25% |
| GF | EP | GI | 0.107 | 0.301 | 35.55% |

IV, independent variable; DV, dependent variable; MV, mediating variable; IE, indirect effect; TE, total effect

the interactions between FA, GF, and EP. The findings of the study are summarized in Fig. 4. The empirical findings supported our hypothesized effect of FA on the EP of commercial banks during the pandemic, implying that FA plays an important role in firms’ achievement of environmental sustainability. Specifically, FA promotes firms’ pro-environmental activities through the incorporation of eco-friendly advanced technologies, such as digital and mobile banking and remote customer care services. Similar findings have been reported by Awawdeh et al. (2022), who discovered that technological innovation enhances EP significantly. Also, Dwivedi et al. (2021) indicated that FA increases the efficiency of the banking sector. Therefore, it is recommended that banks incorporate eco-friendly activities into their daily operations to achieve organizational environmental sustainability.

Furthermore, the empirical findings demonstrated that FA and banks’ GF are positively and significantly related,

implying that FA can strengthen green financing by allowing access to fresh capital and investment sources, including digital financing (Dorfleitner and Braun 2019). The finding is consistent with that of Cen and He (2018), who stated that Fintech promotes GF. Fintech combines advanced technologies such as big data and artificial intelligence (AI) to drive a green economy (Wang et al. 2022a, b). Moreover, the results showed that FA positively influences banks’ GI during the pandemic. This means that Fintech implementation contributes significantly to the increasing adoption of eco-sustainable initiatives by commercial banks during the pandemic, thereby aiding their achievement of environmental sustainability (Adegbile et al. 2017). Although this is among the first studies to investigate the FA-GI relationship in the setting of banking institutions during the pandemic, few studies have also evidenced the existence of an association between the two factors in other settings (Salampasis and Mention 2018; Xiong and Sun 2022; Xue et al. 2022).

The existing findings on the relationship between GF and GI are inconclusive (Wang et al. 2022a, b), as GF is said to promote GI in developing economies and nations with lower levels of GF but lowers it in nations with better technological practices or EP. However, our study found that GF has a significant beneficial impact on GI, asserting that banks financing pro-environmental projects such as internet banking, eco-friendly technology, remote customer service, and phone banking can help organizations

Table 7 Outputs of the OLS regression model

| SL | Path coefficients | β -values | <i>t</i> -statistics | <i>p</i> -values | Results |
|----------------------------|-------------------|-----------------|----------------------|------------------|-------------------|
| H ₁ | FA—> EP | 0.201 | 3.595 | 0.000 | Accepted |
| H ₂ | FA—> GF | 0.593 | 11.775 | 0.000 | Accepted |
| H ₃ | FA—> GI | 0.361 | 5.974 | 0.000 | Accepted |
| H ₄ | GF—> GI | 0.333 | 5.793 | 0.000 | Accepted |
| H ₅ | GF—> EP | 0.278 | 5.223 | 0.000 | Accepted |
| H ₆ | GI—> EP | 0.296 | 5.804 | 0.000 | Accepted |
| Mediation analysis results | | | | | |
| H ₇ | FA—> GI—> EP | 0.308 | 4.162 | 0.000 | Partial mediation |
| H ₈ | GF—> GI—> EP | 0.107 | 4.101 | 0.000 | Partial mediation |

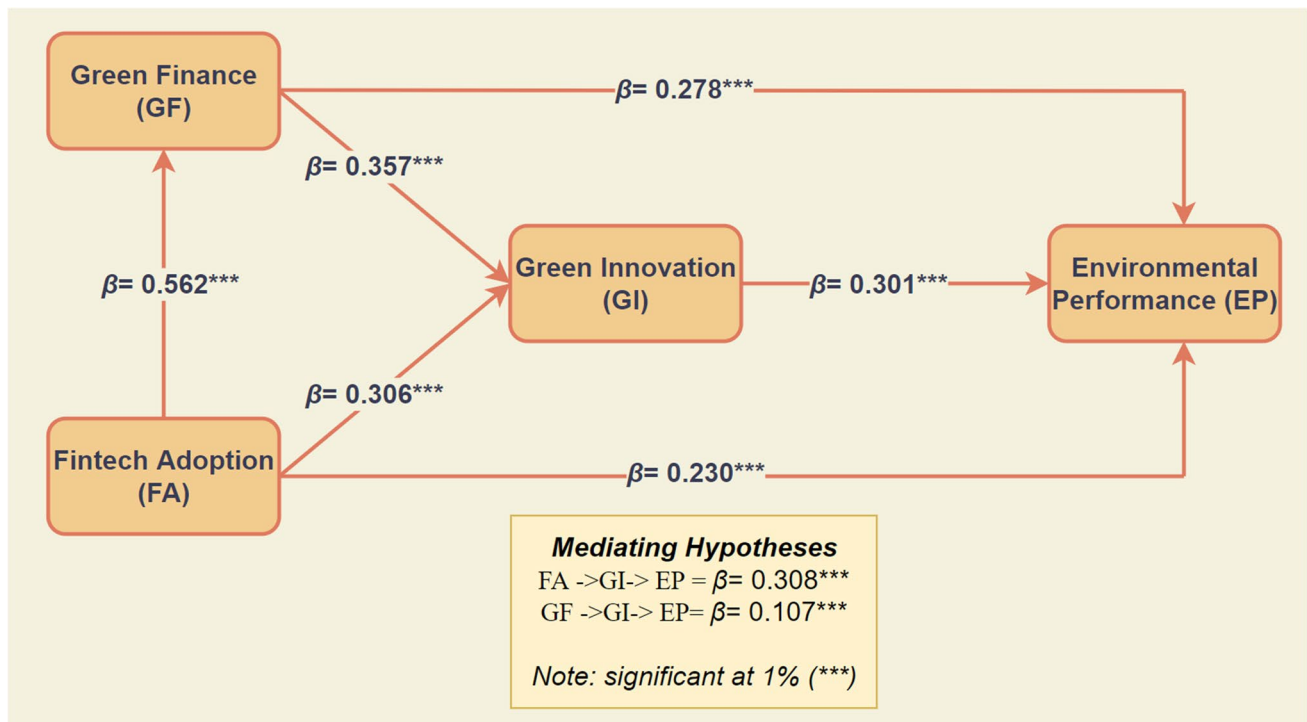


Fig. 4 Structural model

to improve their green innovation. Moreover, Xiong and Sun (2022) established that green insurance and structure encourage green investment and innovation. As a result, GF can be regarded as playing a critical role in enabling organizations to implement green initiatives during the epidemic.

As expected, the outcomes showed that banks' EP is influenced by GF and GI during the COVID-19 pandemic. This suggests that investing in environmentally friendly projects and implementing green initiatives can help firms achieve better environmental outcomes during and after the pandemic. These findings are in agreement with the earlier studies (Awawdeh et al. 2022; Chen et al. 2022; Zhang et al. 2022), which reported a favorable association between GF and EP. Likewise, Indriastuti and Chariri (2021) established that green investment contributes favorably to an organization's sustainability performance. The positive relationship between GI and EP has also been confirmed in several other studies (Adegbile et al. 2017; Kraus et al. 2020). Hence, GF and GI can be considered essential for the achievement of organizational environmental sustainability during and after the epidemic.

Finally, the mediation analysis revealed that the effect of FA on the EP of PCBs is partially mediated during the pandemic. This suggests that FA has both direct and indirect effects on the banks' EP through GI during the pandemic. Furthermore, the empirical findings indicated

that GI acts as a partial mediator between GF and EP, implying that banks' green initiatives like eco-friendly technology, online and mobile banking, and remote customer support are critical in improving the relationship between GF and EP during the pandemic. To reiterate, GF and FA greatly improve GI, which eventually results in better EP of organizations. As no prior study has been conducted on the link between FA, GF, and EP, alongside the mediating role of GI during the pandemic, the current study represents a significant contribution to the literature. Generally, FA, GF, and GI significantly enhance EP during the pandemic by lowering carbon emissions, energy consumption, and paper usage and providing green training to staff. Hence, bank executives should concentrate on technical advancements, green technologies, and funding of pro-environmental projects to increase their overall environmental performance and aid the country's sustainable development.

Conclusion

Using the SEM approach, this study has successfully confirmed the impact of FA on GF, GI, and EP of the financial sector in developing nations such as Bangladesh during the pandemic. The current research also validated the role of GI as a mediator in the association between Fintech adoption,

GF, and EP. The empirical results demonstrated the significant positive effect of FA on GF, GI, and EP; GF on GI and EP; and GI on EP. Furthermore, the results revealed that GI has a partial mediation role in the link between FA, GF, and EP. The study generally underscores the important contribution of FA, GF, and GI to the attainment of greater EP as well as advises the need for the banking industry to prioritize the integration of Fintech and green financing into their operation to expedite the country's sustainable development goals.

Theoretical and practical contributions

The study's findings provide significant theoretical and practical contributions to the fields of FA, GF, GI, and environmental sustainability during crisis period like the pandemic. Theoretically, it expounds on the link between FA, GF, and banks' EP during the pandemic, alongside the mediating role of GI. The current study is the first to investigate FA, GF, GI, and EP under a unified framework. Furthermore, this research demonstrates how banking institutions of emerging markets can leverage Fintech, GF, and GI to improve their EP during the crisis period. In practice, the findings indicate that the incorporation of Fintech, GF, and GI into banking institutions' routine activities is crucial to their achievement of sustainable EP during the pandemic. The study's outcomes provide many practical managerial suggestions for managers in the banking industry as well as legislators. These include the adoption of the latest and advanced innovations and investment in eco-friendly projects to avert environmental degradation, the promotion of pro-environmental attitudes among managers, and the implementation of green and innovative culture within the firm. Also, the central bank and government of Bangladesh can promote GF and GI by introducing a reward system for banking institutions that utilize the latest eco-supportive technologies, such as AI, blockchain, internet, and phone banking, as well as prioritize investment in pro-ecological projects such as clean energy, pollution reduction, and carbon-neutral industry. In essence, the study outcome encourages managers and policymakers to embrace new technology, GF, and GI to promote EP.

Study's limitations and directions for future research

Despite the significant contribution of this study to the publications on FA, GF, GI, and EP, it has several shortcomings that could be leveraged for future research. First, the sample population of this study was restricted to 302 staff of Bangladeshi banking institutions; hence, the findings may not be generalizable to other developing nations or economic sectors. Future research may employ larger samples, as well as include other countries and industries, to verify the generalizability of our findings. Second, the

study investigated the impact of FA on GF and EP during the pandemic, using GI as a potential mediator. However, other mediators such as technological knowledge, employee green behavior, and environmental strategy could be investigated to enhance the explanatory power of the current model. Furthermore, future research may examine the impact of the pandemic by comparing the existing findings with fresh evidence (post-pandemic period). Finally, the EP measurement items did not consider whether the analyzed organizations engage in sustainability policies and programs to demonstrate their compliance with legislation or their dedication to environmental sustainability performance. As a result, future research may focus on alternative facilitators, accelerators, and stimuli for environmental sustainability.

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Data availability The data that support the findings of this study are available from the corresponding authors (A.B.S.) upon reasonable request.

Declarations

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Conflict of interest The authors declare no competing interests.

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