economies

MDPI

Article

Green Finance and Fintech Adoption Services among Croatian Online Users: How Digital Transformation and Digital Awareness Increase Banking Sustainability

Hrvoje Serdarušić [1], Mladen Pancić [1,*] and Željka Zavišić [2]

[1] Faculty of Economics in Osijek, Josip Juraj Strossmayer University of Osijek, 31000 Osijek, Croatia; hrvoje.serdarusic@efos.hr
[2] Effectus University of Applied Sciences, 10000 Zagreb, Croatia; zzavisic@effectus.com.hr
* Correspondence: mladen.pancic@efos.hr

Abstract: This study delves into the dynamic interplay between green finance, Fintech adoption, digital awareness, and digital transformation in the Croatian banking industry. Amidst the emerging trend of sustainable banking practices and technological advancements, this research aims to examine the influence of green finance on Fintech adoption and banking sustainability. Employing a quantitative research design, this study gathered data through a survey questionnaire of 304 participants, comprising customers and employees of various banks in Croatia. The respondents' insights were analyzed using IBM SPSS for the demographic analysis and SmartPLS for structural equation modeling (SEM). The results reveal a significant impact of green finance on Fintech adoption and digital awareness. Additionally, digital awareness significantly influenced Fintech adoption. However, the direct effect of digital transformation on Fintech adoption was not significant. This study also confirmed the significant influence of Fintech adoption on banking sustainability and identified the mediating role of digital awareness between green finance and Fintech adoption. This research contributes novel insights into the relationship between sustainable finance initiatives and digital banking trends. It underscores the need for increased digital awareness and the integration of green finance principles in the banking sector. These findings offer practical implications for banks in Croatia, suggesting a strategic focus on digital awareness programs, leveraging Fintech for enhanced customer experience, and fostering collaboration for a conducive Fintech environment.

Keywords: fintech adoption; green finance; digital awareness; digital transformation; Croatian banking industry

Citation: Serdarušić, Hrvoje, Mladen Pancić, and Željka Zavišić. 2024. Green Finance and Fintech Adoption Services among Croatian Online Users: How Digital Transformation and Digital Awareness Increase Banking Sustainability. *Economies* 12: 54. https://doi.org/10.3390/economies12030054

Academic Editors: Abdalmuttaleb Al-Sartawi, Wajeeh Elali and Khaled Hussainey

Received: 21 December 2023
Revised: 18 February 2024
Accepted: 19 February 2024
Published: 22 February 2024

1. Introduction

The banking industry has experienced a shift due to the emergence of Fintech, which combines finance and technology. Náñez Alonso (2023) shows Central Bank Digital Currencies (CBDCs) can be green and sustainable depending on a country's electricity prices, renewable energy production, CO_2 emissions, and CBDC design. Green digital finance has advanced in the Bahamas and Jamaica, highlighting the need for cleaner energy sources for CBDC sustainability (Náñez Alonso 2023). On the other hand, Corbet and Yarovaya (2020) emphasize cryptocurrency markets' environmental impact; particularly, mining has high electricity use. Despite its complexity, this highlights the importance of environmental issues for investors because electricity consumption directly affects mineable cryptocurrency valuations and investment returns. This change is particularly evident in the field of finance, where it plays a role in promoting sustainability.

Several studies conducted by Elsinger et al. (2018), Kasturi (2023), Rehman et al. (2023), and Udeagha and Muchapondwa (2023) highlight the increasing trends of Fintech in enabling finance and its potential to enhance sustainability within the banking sector. This trend is not confined to any region but extends across various areas ranging from

well-developed banking sectors in Europe to emerging economies in Asia and Africa. The research delves into aspects related to this intersection, such as the utilization of transformation in banking (Rodríguez-Espíndola et al. 2022), the impact of Fintech on banking models (Lee and Shin 2018; Folwarski 2021; Sarfraz et al. 2022), and how raising awareness about issues can foster the adoption of Fintech (Lee and Shin 2018). Despite there being a body of literature, it reveals gaps in understanding the relationship between finance, digital transformation, and digital awareness, specifically within the Croatian banking sector.

The research conducted by Udeagha and Muchapondwa (2023) and Muganyi et al. (2021) provides insights into the role of Fintech and green finance in promoting sustainability. However, these studies overlook the context of the Croatia banking industry. It is important to consider this omission because regions have regulatory frameworks that influence the adoption and effectiveness of Fintech and green finance initiatives. Additionally, Lee and Shin (2018), Sarfraz et al. (2022), and Rodríguez-Espíndola et al. (2022) emphasize the importance of transformation and awareness. In the banking industry few studies integrate these aspects with finance and Fintech adoption in a comprehensive model. Nassiry (2018), Omarini (2017), and Folwarski (2021) have highlighted this lack of integration in context research, arguing that understanding the interaction between these variables would be crucial for driving changes in banking practices, but it has not received attention.

Another notable gap in the research is the investigation into the cause-and-effect relationship between Fintech adoption and green finance possibilities. While studies like those conducted by Yan et al. (2022) and Liu et al. (2022) offer evidence on how Fintech impacts finance, less focus has been placed on exploring how green finance initiatives stimulate Fintech adoption and drive digital transformation within the banking industry.

According to the research conducted by Danladi et al. (2023) and Mavlutova et al. (2022), it is crucial to consider the role of awareness in the adoption of Fintech and the potential impact of finance, particularly in emerging economies and rapidly digitizing industries. Previous studies have overlooked these aspects, creating a gap that needs to be addressed in order to develop strategies within the banking industry.

This study aims to fill these gaps and contribute to the Croatian banking industry. Its focus is on understanding the dynamics between finance, digital transformation, and digital awareness in driving Fintech adoption within the Croatian banking sector. It is worth noting that this specific aspect has not been adequately covered in the literature, including the works by Dapp (2017) and Dell'Erba (2021). Additionally, this research seeks to explore the relationship between Fintech adoption and green finance, investigating how each factor is influenced by digital elements. These perspectives are notably absent from the studies conducted by Guang-Wen and Siddik (2023) and Abdul-Rahim et al. (2022).

By combining these elements into a framework, this research will provide insights for professionals in the industry and policymakers. This will guide them in developing strategies that effectively leverage transformation, Fintech adoption, and green finance initiatives. Additionally, this study aims to achieve the research objectives:

1. To examine the influence of green finance on Fintech adoption, digital transformation, and digital awareness, in turn, on banking sustainability in the Croatian banking industry.
2. To examine the influence of digital transformation and digital awareness on Fintech adoption in the Croatian banking industry.
3. To explore the mediating role of digital transformation and awareness between green finance and Fintech adoption in the Croatian banking industry.

2. Literature Review

2.1. Underpinning Theory to Support Digitalization and Sustainability

The resource-based view (RBV) provides insights into the adoption of Fintech and the sustainability of banking. According to Gupta et al. (2018) and David-West et al.

(2018), information systems and digital capabilities are assets in the banking sector. These studies illustrate how digital financial services will be leveraged as an advantage that ensures long-term success, aligning with the RBV's core principles of utilizing resources for sustainable performance. Chaudhuri et al. (2022) also underscore the significance of capabilities in medium-sized enterprises (SMEs), particularly within the context of the circular economy. This perspective expands upon the RBV by integrating sustainability and customer value, suggesting that transforming banking through means can enhance both sustainability efforts and customer satisfaction.

In addition, Nagy et al. (2018) delve into how the Indian engineering industry embraces technologies within Industry 4.0. Their research carries implications for banking, where adopting Fintech represents a leap forward. Based on their analysis grounded in the RBV, they propose that integrating technology enhances efficiency and competitive positioning, which are aspects of sustainable banking practices. Shibin et al. (2020), combining the RBV with theory, examine supply chain management practices in SMEs while highlighting how digital technologies can foster sustainability.

This suggests that incorporating Fintech into the banking industry enhances sustainability and efficiency according to the RBV. The studies conducted by Rajkumar et al. (2020) on Fintech awareness and impact demonstrate the growing significance of understanding Fintech and its practical application in banking. These studies align with RBV's emphasis on knowledge and capability management, highlighting the role of awareness and knowledge in adopting Fintech. Additionally, Yadav et al.'s (2022) research on financial literacy among women reinforces the importance of widespread digital education for driving the adoption of Fintech.

2.2. Green Finance and Fintech Adoption (Online Payment)

Green finance plays a positive role in the uptake of Fintech (online payments) within the banking sector. Empirical research conducted by Guang-Wen and Siddik (2023) and Udeagha and Muchapondwa (2023) provides evidence of the significant impact of green finance factors on the adoption of Fintech across various regions. These studies highlight that incorporating practices in financial services often driven by consumer demands and regulatory requirements accelerates the adoption of innovative financial technologies. Given the shift toward sustainability and consumers' increasing preference for responsible banking practices, this connection holds particular relevance in the context of the Croatian banking industry. Additionally, Lee and Shin (2018), Golubić (2019), Yan et al. (2022), and Muganyi et al. (2021) further support this notion by demonstrating how embracing Fintech with support from finance enhances the sustainability performance of banking institutions. This indicates a growing trend where financial organizations utilize Fintech to enhance their sustainability efforts by aligning with principles espoused by finance (Golubić 2019). Furthermore, the research on the implications of transformation in the financial sector reinforces the idea that green finance promotes the adoption of Fintech.

For instance, the research conducted by Omarini (2017), Lee and Shin (2018), Folwarski (2021), and Sarfraz et al. (2022) reveals the impact of transformation on the banking sector, specifically emphasizing the significance of adopting Fintech. These studies highlight that embracing finance is an effort to stay competitive and relevant in an increasingly digitalized financial landscape, driven by both regulatory requirements and environmental considerations. Incorporating Fintech payment systems while adhering to green finance principles within the Croatian banking industry can be seen as a strategic response to evolving customer preferences and market conditions. Additional research by Dapp (2017) and Barroso and Laborda (2022) demonstrates that this adoption aligns with trends. Finally, this study proposes a research hypothesis:

H1. *Green finance significantly and positively influences Fintech (online payment) adoption in the Croatian banking industry.*

2.3. Green Finance and Green Awareness

Various literature trends and research findings strongly support the idea that green finance has a positive impact on raising awareness about issues within the banking industry. Lapinskienė and Danilevičienė (2023) and Abuatwan (2023) explore the sustainability performance of the banking sector, and the role of its presence in moderating it reveals that green finance influences practices, awareness within the sector, and people's perceptions. This research suggests that implementing finance strategies can enhance consciousness in banking operations, leading to more sustainable practices. In another vein, Liu et al.'s (2022) investigation into how green financing affects energy efficiency demonstrates how such initiatives can foster environmental awareness and sustainable practices across industries.

Furthermore, Udeagha and Muchapondwa (2023) and Tamasiga et al. (2022) provide evidence showing how green finance initiatives promote sustainability and environmental awareness in the economy. These studies highlight the role of green finance in shaping industry norms and practices while influencing environmental sustainability awareness among banks. In addition, Nassiry (2018) also discusses Fintech's potential to facilitate finance adoption as a step toward creating an environmentally conscious and technologically advanced banking sector. Therefore, these collective insights give rise to a hypothesis:

H2. *Green finance significantly and positively influences green awareness in the Croatian banking industry.*

2.4. Green Awareness and Fintech Adoption (Online Payment)

The hypothesis that being aware of issues has a positive impact on the adoption of Fintech (online payment) in the banking industry highlights the importance of awareness and understanding in technology adoption. For example, Hanafizadeh and Khedmatgozar (2012) found that customer awareness played a role in the adoption of Internet banking, suggesting a pattern for Fintech adoption. As customers and banks become more knowledgeable about initiatives, they are more likely to embrace Fintech solutions that align with these values (2019). Namahoot and Laohavichien (2018) focus on behavioral intentions and the relationship between service quality, perceived risk, and the influence of trust on customers' use of internet banking. Research by Handro (2018) and Rajkumar et al. (2020) demonstrates how individual knowledge about Fintech strongly influences its adoption. In light of this, it can be inferred that green awareness drives the increased adoption of Fintech solutions within the Croatian banking industry with those that promote sustainability.

Furthermore, Sarfraz et al. (2022) and Mavlutova et al. (2022) present a framework for understanding the relationship between transformation and sustainability. These studies illustrate how as banks incorporate sustainability goals into their transformation efforts, there is an increase in the adoption of Fintech solutions. Aboalsamh et al. (2023) and Mejia-Escobar et al. (2020) highlight this trend, emphasizing the role of sustainable finance in advancing different sectors. Taking into account these pieces of literature evidence, this study supports the following research hypothesis:

H3. *Green awareness significantly and positively influences Fintech (online payment) adoption in the Croatian banking industry.*

2.5. Green Finance and Digital Transformation

Studies linking financial sustainability practices to technological innovation and adoption support the hypothesis that green finance positively impacts digital transformation in the banking industry. Authors such as Macchiavello and Siri (2022) suggest that green finance principles are closely linked to digital transformation initiatives in the banking sector and that 'green Fintech' and 'sustainable digital finance' is essential to maintain

environmental goals. Udeagha and Muchapondwa (2023) examine how green finance and Fintech promote environmental sustainability.

Bayram et al. (2022) and Guang-Wen and Siddik (2023) investigate the positive impact of green finance-driven Fintech adoption on the environmental performance of banking institutions. It has been found that initiatives promoting finance are closely linked to the transformation of banking processes, with technological innovation being a significant driver toward achieving sustainable financial performance. The shift toward solutions is not only strategic for enhancing operational efficiency but also for meeting the demands of sustainable finance, thus fostering an integrated approach toward environmental stewardship and technological advancement in banking. Consequently, this study proposes a research hypothesis:

H4. *Green finance significantly and positively influences digital transformation in the Croatian banking industry.*

2.6. Digital Transformation and Fintech Adoption (Online Payment)

The adoption of Fintech in the banking industry is significantly and positively influenced by the green transformation. According to Chueca Vergara and Ferruz Agudo (2021), green banking transformation leads to the increased adoption of Fintech, including payments. Fintech supports the growing demand for financial practices due to its efficiency and resource effectiveness. In addition, Aboalsamh et al. (2023) found that banks are more inclined to adopt and integrate Fintech solutions that align with their sustainability goals during their transformation.

Furthermore, Nenavath and Mishra (2023) explore how Fintech and green finance impact environmental quality protection, which demonstrates how adopting practices and financial technologies can create a sustainable banking environment. Banks require this integration in Croatia where environmental objectives are gaining importance. The green transformation of banking addresses both regulatory requirements and consumer demands for sustainability while also fueling innovations, like payment systems. Based on the existing literature evidence, a research hypothesis has been formulated:

H5. *Green transformation significantly and positively influences Fintech (online payment) adoption in the Croatian banking industry.*

2.7. Mediation of Digital Awareness between Green Finance and Fintech Adoption (Online Payment)

The research indicates that having knowledge about platforms and understanding their potential in supporting financial practices positively influences the relationship between green finance and the adoption of Fintech in the banking industry. According to Handro (2018), Hanafizadeh and Khedmatgozar (2012), and Duhnea and Schipor (2021), an improved digital awareness reduces the perceived risks and barriers associated with adopting Fintech solutions. This implies that by enhancing their understanding of platforms, individuals can be more open to embracing Fintech online payment systems in the context of green finance. Furthermore, Lee and Shin (2018) emphasize the significance of financial awareness among households for the successful adoption of new financial technologies. Therefore, it is suggested that by increasing awareness within the Croatian banking sector, customers may become more receptive to Fintech solutions driven by finance.

In addition to this mediation relationship between finance and Fintech adoption, Muganyi et al. (2021) and Sarfraz et al. (2022) highlight the broader context of green finance and digital transformation in banking. Banks should focus on raising both consumer and institutional awareness about technologies to effectively implement and utilize Fintech solutions while adhering to finance principles (Lee and Shin 2018; Sarfraz et al. 2022; Muganyi et al. 2021). It is crucial for individuals within these institutions to have a grasp on

practices so that they can ensure that Fintech solutions, especially online payments systems, are technically viable and aligned with sustainability goals set by green finance initiatives.

Therefore, the research provides a hypothesis that acts as a mediator:

H6. *Digital awareness significantly and positively mediates the relationship between green finance and Fintech (online payment) adoption in the Croatian banking industry.*

2.8. Mediation of Digital Transformation between Green Finance and Fintech Adoption (Online Payment)

Digitalization plays a role in merging finance with modern financial technologies. Researchers such as Lee and Shin (2018), Duhnea and Schipor (2021), Sarfraz et al. (2022), and Mavlutova et al. (2022) demonstrate how digital transformation incorporates practices into operations, including the adoption of Fintech. To promote finance, it is essential to have a technologically adept banking sector that embraces new financial technologies. In this context, digital transformation refers to the adoption of technologies and the creation of a banking ecosystem that supports sustainability goals. Through transformation, the banking sector can effectively align finance initiatives with the operational advantages and customer-centric benefits offered by Fintech, particularly in terms of online payments.

Moreover, the studies conducted by Dapp (2017) and Omarini (2017) highlight the significance of the advancements in facilitating the adaptation of banks to emerging paradigms, like finance. This evolution entails financial institutions adopting technologies and restructuring their frameworks to meet sustainability objectives. Digital transformation in banks acts as a mediator between finance and Fintech adoption (Golubić 2019). Therefore, for integration between finance and Fintech, particularly online payment systems, it is crucial for the Croatian banking industry to undergo comprehensive digital transformation processes. Based on these justifications, this study formulates a research hypothesis:

H7. *Digital transformation significantly and positively mediates the relationship between green finance and Fintech (online payment) adoption in the Croatian banking industry.*

2.9. Green Adoption (Online Payment) and Banking Sustainability

This section provides evidence that green adoption has a positive impact on the sustainability of banks. For example, Lee and Shin (2018), Udeagha and Muchapondwa (2023), and Abuatwan (2023) demonstrate how incorporating finance into banking operations not only enhances sustainability but also sets a precedent for the entire industry. This emerging trend shows that the implementation of policy measures and conscious investments contributes to the long-term sustainability of the banking sector. In addition, banks in many countries have already introduced practices that reflect the growing recognition of responsibility as a crucial aspect of banking sustainability (Udeagha and Muchapondwa 2023). Additionally, Yan et al. (2022) and Muganyi et al. (2021) highlight how innovation through Fintech solutions further improves the sustainability of banks. These studies suggest that by combining finance initiatives with Fintech approaches, banks achieve higher levels of sustainable operations. Drawing from these pieces of literature evidence, this study proposes a research hypothesis:

H8. *Green adoption significantly and positively influences banking sustainability in the Croatian banking industry.*

Based on the literature's pieces of evidence and hypothetical expressions, this study develops a research framework to test the hypotheses (Figure 1).

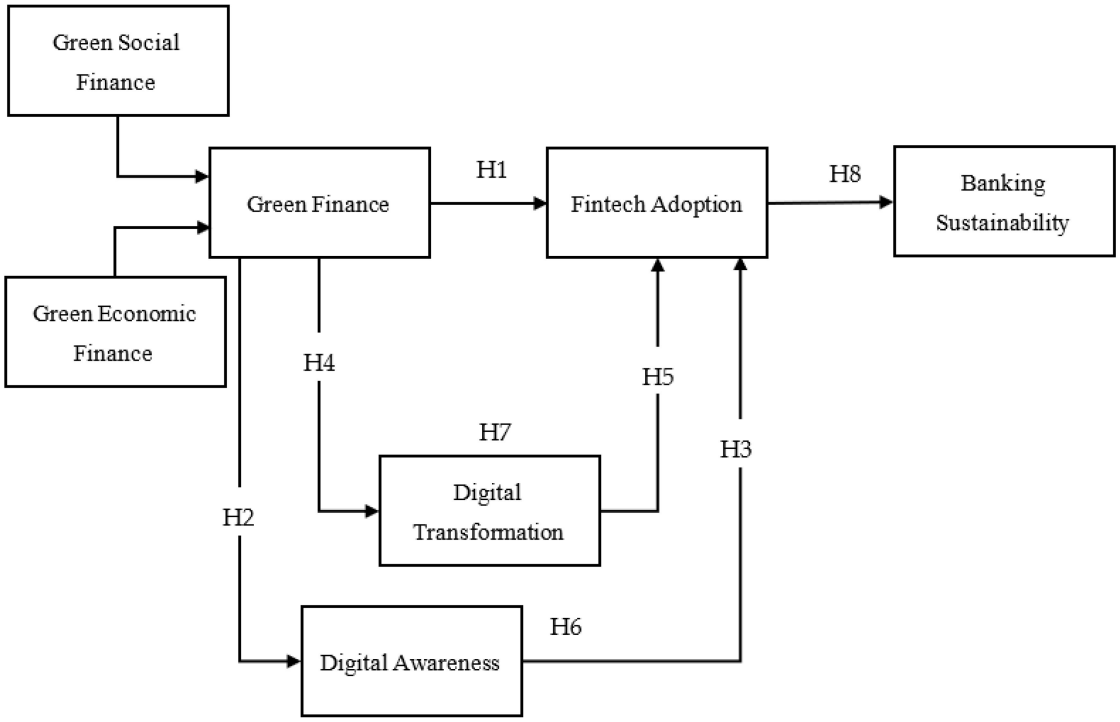

Figure 1. Theoretical framework.

3. Research Methodology

3.1. Quantitative Research Design

As highlighted by Haq (2014) and Leavy (2022), the benefits of using a quantitative research approach prove valuable in assessing and understanding the interplay of factors in banking sustainability and the adoption of Fintech. According to Haq (2014), quantitative research offers an overview in which the desired results can be generalized. This methodology is well suited for gathering data from samples, such as the banking sector, and statistically analyzing variables, like finance and Fintech adoption. Through methods, this study identifies patterns, trends, and correlations across sectors. In addition, Leavy (2022) emphasizes how quantitative research serves to validate theories and hypotheses. As banks embrace practices alongside Fintech advancements, theories related to sustainability, digital transformation, and financial innovation can be empirically tested and substantiated. Surveys and questionnaires form the tools employed in collecting the data directly aligned with our research questions and hypotheses. Thus, this study adopts a research design.

3.2. Data Collection Procedure

The main approach used in this study to collect data was a survey questionnaire, which is widely recognized for its effectiveness in gaining insights into how consumers perceive their attitudes, satisfaction levels, and future behaviors (Bryman 2016). This study used multi-stage sampling methods to target both customers who have had experience with Fintech services (online banking) and employees of Croatian banks. The data for the variable banking sustainability were collected through direct personal contact with the bank employees at all operational levels while we disseminated and collected data from users of Fintech services on the variables of green finance, digital transformation, digital awareness, and Fintech adoption via various social networks as well as through personal contact.

The questionnaire collected information from customers regarding finance, the adoption of friendly practices, digital transformation, and digital awareness. The data on the sustainability of banks were collected from bank employees. The fact that these individuals actively use applications for banking highlights their interest in financial technology. A

survey aimed to gather information on aspects such as finance, the adoption of sustainable practices, and digital transformation and awareness among customers while also obtaining insights on banking sustainability from bank employees. In addition, bank employees provided information on the company's performance in terms of sustainability. As this group of respondents has experience with Fintech systems and services, they are in a unique position to provide insights into areas such as data usage practices, service quality, and overall customer satisfaction related to Fintech.

As Creswell (2014) points out, employees participating in data collection is essential. This helps us to understand the banks' strategies and performance indicators. Employees' comments play a role in improving the quality of the study data. Together with customer feedback, they provide a perspective on the sustainability performance of companies. Fowler (2014) emphasizes the effectiveness of self-report surveys in capturing assessments and personal experiences. Both customers and bank employees were given questionnaires to share their experiences and opinions. The survey was distributed to 423 participants, including both employees and customers. Initially, on 12 June 2023, we received 37 responses from customers and 45 responses from employees. Follow-up reminders were sent out on June 15, resulting in 101 customer responses and 78 additional staff responses. On July 3, further reminders led to 21 staff responses and 22 more customer responses. To ensure balance within our dataset, we requested responses from bank staff members, ultimately reaching a final count of 304 total responses.

The final response rate of 71.87% provides an analysis of the factors that influence online banking, such as system quality, information quality, service quality, customer satisfaction, Fintech behavioral intention, digital awareness, digital transformation, and firm sustainable performance.

3.3. Measurement Scales

This research incorporated measurement scales from the literature studies, which had been validated and proven reliable (with a score of >0.70). This allowed this study to empirically test the existing theory, making use of reliable scales. Four items for Fintech adoption (payment) were adapted from Rehman et al. (2023), alongside four items for sustainability and eight items for finance (four for economic green finance and four for social green finance), which were taken from Abuatwan's (2023) research. This study employed a second-order measurement model using finance as suggested by Hair et al. (2021). Additionally, four items related to awareness were adopted from Hanafizadeh and Khedmatgozar's (2012) study while three items concerning transformation were taken from Rodríguez-Espíndola et al.'s (2022) research.

The customer survey questionnaire contains the following items/questions about the variables: green finance, digital transformation, digital awareness, and Fintech adoption. On the other hand, the banking employees' survey questionnaire included the following items/questions about the following variable: banking sustainability. All measures were assessed using 5-point Likert scales ranging from 1 = strongly disagree to 5 = strongly agree.

3.4. Data Analysis

It is widely recognized that social science researchers often use IBM SPSS for data management and an initial statistical analysis (Pallant 2020). According to Pallant (2020), the software was chosen for the phase of this study due to its flexibility in conducting statistical analyses and its effectiveness in handling large datasets. By utilizing the SPSS descriptive analysis, it offers an initial assessment of sample characteristics and variable distributions. Once this step is completed, the study progresses to employing SmartPLS, a tool for structural equation modeling (SEM) introduced by Ringle et al. (2022). SEM is a method used to determine how green finance factors affect sustainable development (Kamis et al. 2020). SmartPLS, which utilizes the squares (PLS) path modeling algorithm recommended by Hair et al. (2021), proves particularly useful in predictive studies where

data distributions are non-normal. This approach is well suited for models with indicators and variables. Ringle et al. (2020) also mentioned that one advantage of PLS SEM is its ability to simultaneously evaluate measurement models, establishing the precision and reliability of variables while clarifying the strength and direction of their relationships. Therefore, in order to comprehensively test the research hypotheses, this study employed an equation modeling approach based on Partial Least Squares (PLSs) as described by Roemer et al. (2021).

4. Findings of the Study

4.1. Demographic Analysis

Table 1 presents detailed descriptions of the survey results from the 304 participants. The focus was on their usage of Fintech applications, reasons for using these services, gender distribution, experience with banking, and education levels. Around 53.9% of the respondents prefer using online mobile applications given by banks, while 46.1% opt for other platforms for money transfer services, like Apple pay, Google Pay, Revolut, PayPal, Aircash, Western Union, and MoneyGram. This shows that there is a range of engagement with Fintech platforms. When it comes to the purpose behind using these services, the majority (66.1%) use them for shopping, followed by 25% who use them for sending funds and 8.9% who utilize them for other purposes. This highlights how versatile Fintech is in meeting needs. In terms of the gender distribution within the survey group, it heavily skews toward males with around 87.8%, while 12.2% identify as female, indicating a gender gap in Fintech usage patterns. The respondents experience with banking is varied across durations; approximately 36.5% have been using it for 1–3 years and around 32.2% have been using it for 4–6 years, suggesting that there is a relatively experienced user base when it comes to online banking activities among Fintech users in this survey sample size. As far as their education is concerned, most of them (86.9%) have a Master's degree in education.

Table 1. Demographics.

Demographics	Details	Categories	Frequency	Total Frequency	Percent
Fintech Apps					
	Online mobile applications	Employees	123	164	53.9%
	Apple pay/Google Pay/Revolut/PayPal, Aircash/Western Union/MoneyGram	Customers	181	140	46.1%
Purpose of Use					
	Sending Funds			76	25.0%
	Shopping			201	66.1%
	Educational Purpose			27	8.9%
Gender					
	Male			267	87.8%
	Female			37	12.2%
Online Banking Experience					
	Less than 1 Year			24	7.9%
	1–3 Years			111	36.5%
	4–6 Years			98	32.2%
	More than 6 Years			71	23.4%
Education					
	High School			4	1.3%
	Bachelor's Equivalent Degree			55	18.1%
	Master Equivalent Degree			209	68.8%
	Postgraduate or PhD Degree			36	11.8%
Total				304	100.0%

4.2. Assessment of Measurement Model

In the field of finance and technology, using structural equation modeling (SEM) to assess measurement models provides insights into the reliability and validity of the concepts being studied. These models are crucial for understanding the factors that drive behaviors and outcomes in decision making, digital engagement, and sustainability efforts. When researchers evaluate these concepts, which encompass everything from the social aspects of finance to the complexities of digital transformation, Fintech adoption and banking sustainability rely on statistical measures to ensure that the models accurately represent what they intend to measure. These measures include factor loadings, the average variance extracted (AVE), Cronbach's alpha, and composite reliability. Each of these serves a purpose in validating the robustness of these concepts.

Detailed information about the factor loadings, average variance extracted (AVE), Cronbach's alpha, and composite reliability for constructs related to finance digital transformation and sustainability can be found in Table 2. These constructs consist of finance, green social finance, digital transformation, digital awareness, Fintech adoption, and banking sustainability. Each construct is represented by items (for example, GEF1 for economic finance). It is essential to consider the threshold values for the AVE, Cronbach's alpha, and composite reliability when evaluating these constructs.

Table 2. Measurement model.

Variables	Items	Loadings	AVE	Cronbach's Alpha	Composite Reliability
Green Economic Finance	GEF1	0.730	0.674	0.837	0.892
	GEF2	0.855			
	GEF3	0.849			
	GEF4	0.844			
Green Social Finance	GSF1	0.750	0.580	0.758	0.846
	GSF2	0.780			
	GSF3	0.798			
	GSF4	0.715			
Digital Transformation	DT1	0.842	0.703	0.790	0.876
	DT2	0.814			
	DT3	0.858			
Digital Awareness	DA1	0.785	0.679	0.842	0.894
	DA2	0.872			
	DA3	0.809			
	DA4	0.827			
Fintech Adoption	FA1	0.776	0.733	0.877	0.916
	FA2	0.897			
	FA3	0.871			
	FA4	0.876			
Banking Sustainability	BS1	0.853	0.668	0.834	0.890
	BS2	0.809			
	BS3	0.822			
	BS4	0.784			

The AVE, which measures how much of the variance in a construct is captured compared to the measurement error, is generally considered acceptable if it is 0.5 or higher (Dash and Paul 2021). This threshold indicates that on average the construct explains more than half of the variation in its items. All constructs meet this threshold, with the AVEs ranging from 0.580 (green social finance) to 0.733 (Fintech adoption), suggesting satisfactory convergent validity. Cronbach's alpha is a measure of consistency that is considered satisfactory if it is 0.7 or above (Hair et al. 2021). All the constructs meet this criterion, indicating reliability. For example, green economic finance has a Cronbach's alpha of 0.837, which surpasses the threshold, demonstrating that the items within this construct consistently measure the concept. The composite reliability evaluates the consistency of a set of indica-

tors to Cronbach's alpha. A value of 0.7 or higher is generally deemed satisfactory. This indicates reliability (Ringle et al. 2020). All the constructs exceed this threshold, with values ranging from 0.846 (green social finance) to 0.916 (Fintech adoption), further reinforcing their reliability.

When it comes to factor loadings, which show how items are correlated with their constructs, we generally consider values above 0.7 as acceptable. This suggests that the item makes a contribution to the construct. Most of the items in our analysis have loadings above this threshold. The examination of the constructs indicates a measurement model with reliability and validity. The constructs demonstrate consistency as indicated by their Cronbach's alpha and composite reliability values and they show adequate convergent validity based on their AVEs.

4.3. Heterotrait–Monotrait Ratio (HTMT)

The heterotrait–monotrait (HTMT) ratio analysis is a technique used in structural equation modeling (SEM) to evaluate validity. Discriminant validity refers to how much a construct differs from constructs within a model measuring different concepts or phenomena. In an HTMT analysis, values below 0.90 typically indicate validity (Roemer et al. 2021). This threshold suggests that the constructs are distinct enough from each other, ensuring that they are not measuring the thing. In this study, all the HTMT values are below the 0.90 threshold, indicating validity among the constructs. For example, the HTMT ratio between digital awareness and digital transformation is 0.708, which is below 0.90 and shows that these two constructs are separate from each other. Likewise, the relationship between Fintech adoption and green economic finance has an HTMT value of 0.619, further confirming the validity.

Furthermore, the observed HTMT value in this study is 0.890 (between green finance and green economic finance), which is slightly below the threshold. This suggests that while these constructs are closely related, they still maintain a distinction in order to be considered separate loadings (Table 3). It is important because it ensures that each loading brings something to the model and is not a duplicate of another element. The HTMT ratios indicate that the elements in the model have validity (Rasoolimanesh 2022). This discovery is crucial for maintaining the integrity of the equation model as it confirms that each element measures an aspect of the phenomenon being studied. These results validate the use of HTMT as a criterion for assessing validity, reaffirming that the elements in this model are separate and well defined.

Table 3. Heterotrait–monotrait.

Variables	1	2	3	4	5	6
Digital awareness	0.811					
Digital transformation	0.708	0.701				
Fintech adoption	0.687	0.705	0.531			
Green economic finance	0.682	0.713	0.619	0.636		
Green finance	0.766	0.792	0.693	0.696	0.890	
Green social finance	0.715	0.729	0.644	0.631	0.700	0.880

4.4. Model Fitness

When evaluating the effectiveness of structural equation modeling (SEM), researchers often use R square (R^2) and adjusted R^2 values. R^2 indicates the portion of variation in the variable that was explained by the variables included in the model. It helps measure how well the model accounts for these variables. An adjusted R^2 is particularly valuable as it takes into account the number of predictors in the model, providing an assessment of the model fit, especially for models with multiple predictors. Table 4 observes the levels of the R^2 and adjusted R^2 across the constructs, like banking sustainability, digital awareness, digital transformation, Fintech adoption, and green finance. For banking sustainability, this study measures an R^2 of 0.348 and an adjusted R^2 value of 0.346. This suggests that

34.8% of the variations in banking sustainability are accounted for in the model. The slight decrease in the adjusted R^2 reflects an impact to the number of predictors involved. On the other hand, digital awareness demonstrates values with an R^2 value of 0.452 and the model explains there is an adjusted R^2 value of 0.450, indicating a reasonably good fit at nearly 45.2% of its variance.

Table 4. Model fitness.

Variables	R-Square	R-Square Adjusted
Banking sustainability	0.348	0.346
Digital awareness	0.452	0.450
Digital transformation	0.333	0.331
Fintech adoption	0.440	0.434
Green finance	1.000	1.000

Digital banking and sustainability share similarities in terms of their analysis. The R-square value for transformation is 0.333, indicating that the model accounts for 33.3% of its variance. Similarly, the R^2 value for Fintech adoption is 0.440, suggesting that the model explains around 44% of its variance; that is quite significant. However, it is worth noting that green finance shows a fit with an R^2 adjusted value of 1.000, which is highly acceptable. This indicates an issue with overfitting or potential errors in the model or data itself.

The varying levels of model fitness indicated by the R^2 values highlight how well these constructs explain different phenomena, with most displaying a moderate to good level of explanatory power. However, the perfect scores for finance raise questions that require further investigation and validation. These findings align with the principles of structural equation modeling (SEM) (Roemer et al. 2021) and support our understanding of interpreting R-adjusted R square values (Kamis et al. 2020).

4.5. Assessment of Path Model

In the field of structural equation modeling (SEM), variables in a model are categorized as either exogenous or endogenous. Exogenous variables act independently. They are not influenced by variables within the model (Hair et al. 2021). They serve as predictors or causes for the relationships being studied. On the other hand, endogenous variables depend on variables within the model and are influenced by them. They represent the outcomes or effects of the examined relationships. This differentiation is crucial as it determines both the causality direction and how we interpret relationships within the model.

This study investigated eight hypotheses, examining mediating relationships among these endogenous variables (Table 5). The findings derived from analyzing the SmartPLS model indicate that there is an impact of green finance (GF) on Fintech adoption, which is an endogenous variable; GF > FA ($\beta = 0.339$, t-value = 4.653, and $p < 0.000$ ***). Therefore, hypothesis H1 was accepted. Moreover, a positive and significant relationship was found between green finance and digital awareness, GF > DA ($\beta = 0.672$, t-value = 18.707, and $p < 0.000$ ***), leading to acceptance of hypothesis H2. The impact of digital awareness on Fintech adoption (FA) was found to be significant in supporting hypothesis H3. Similarly, green finance had an influence on digital transformation, thus confirming hypothesis H4. However, the direct effect of digital transformation on Fintech adoption was not statistically significant, resulting in the rejection of hypothesis H5. On the other hand, a significant relationship was observed between Fintech adoption and banking sustainability, supporting hypothesis H8. These findings provide an understanding of the connections between the factors in the model and emphasize the significant impact that certain external factors have on specific outcomes.

Table 5. Hypotheses testing.

	Relationships	Direct Beta	Mediating Beta	*t*-Value	*p*-Value	Decision
H1	GF -> FA	0.339		4.653	0.000	Accepted
H2	GF -> DA	0.672		18.707	0.000	Accepted
H3	DA -> FA	0.349		4.737	0.000	Accepted
H4	GF -> DT	0.577		11.029	0.000	Accepted
H5	DT -> FA	0.052		0.892	0.373	Rejected
H8	FA -> BS	0.590		13.457	0.000	Accepted
H6	GF -> DA -> FA		0.234	4.520	0.000	Accepted
H7	GF -> DT -> FA		0.030	0.880	0.379	Rejected

Note: Green finance = GF, Fintech adoption = FA, digital awareness = DA, digital transformation = DT, and banking sustainability = BS.

4.6. Assessing Mediating Effects

The concept of mediation plays a role in equation modeling as it explores the reasons behind and the mechanisms through which certain effects occur between an independent variable and a dependent one. Mediation focuses on understanding whether the relationship between finance and Fintech adoption is influenced by factors such as transformation and digital awareness. To determine the significance of mediation effects, statistical tests are conducted to assess whether there is a zero indirect effect of the independent variable on the dependent variable through the mediator.

In this study, we found that digital awareness significantly mediates the relationship between green finance and Fintech adoption; GF > DA > FA (β = 0.234, *t*-value = 4.520, and $p < 0.000$ ***). This supports hypothesis H6, suggesting that when users are digitally aware and influenced by finance initiatives, they are more likely to adopt Fintech services. On the other hand, this study did not find mediation by digital transformation in the relationship between green finance and Fintech adoption; GF > DT > FA (β = 0.030, *t*-value = 0.880, and $p = 0.379$). Therefore, hypothesis H7 was rejected. These findings indicate that while digital awareness plays a role in facilitating the impact of finance on Fintech adoption, digital transformation does not have a significant mediating effect in this context.

This result shows that digital transformation is a factor in the modernization of services. However, it does not change the impact of finance on the adoption of Fintech in Croatia. As well, Ozili (2024) warns against digital-only financial inclusion (DOFI) due to digital device access disparity, high internet costs, and a focus on digital access over user protection and financial health. Digital IDs increase government surveillance, digital fraud is easy, and power is prioritized over inclusive and secure financial services. There are two implications from these results. First, it emphasizes the need to increase awareness about technologies to promote the use of Fintech services driven by finance. Secondly, while digital transformation is a trend, its role as a mediator between finance and Fintech use is not as significant when it comes to influencing the use of sustainable financial technologies among online users in Croatia (Figure 2).

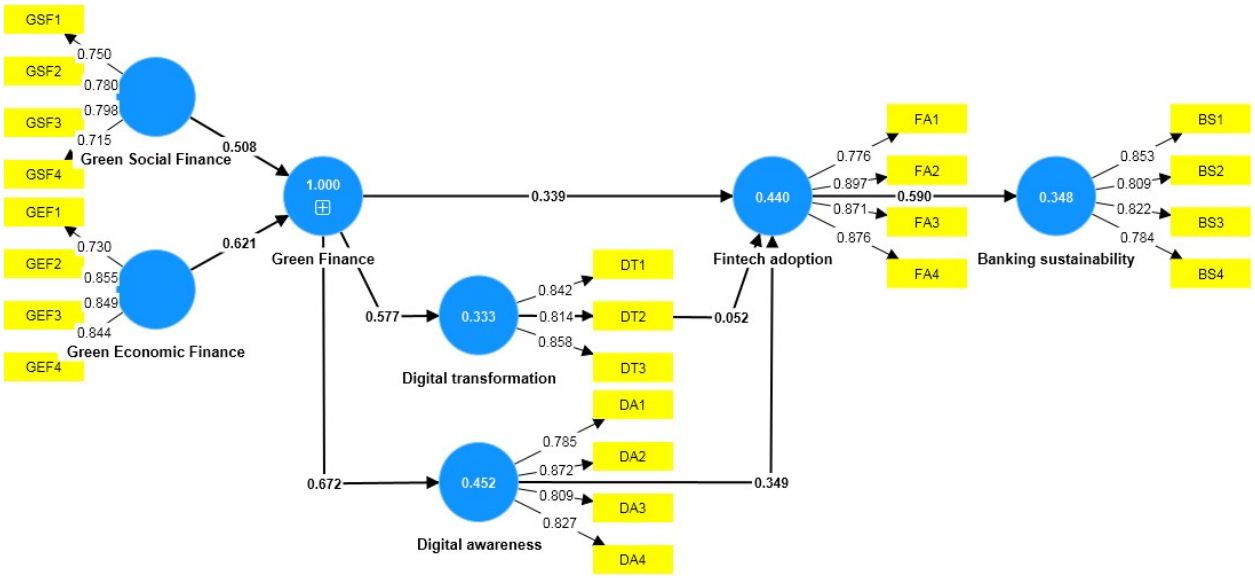

Figure 2. Structural equation modeling (SEM).

5. Discussion

This research was conducted within the Croatian banking industry, focusing on customers and customer care officers. The findings of this study align with research on the adoption of Fintech, green finance, and digital transformation in the banking industry. For instance, Rehman et al. (2023) and Abuatwan (2023) have examined aspects in relation to SMEs and the banking sector, highlighting the role of Fintech in improving banking operations and sustainability. This study also supports the impact of finance on Fintech adoption, which is consistent with Hanafizadeh and Khedmatgozar's (2012) and Namahoot and Laohavichien's (2018) findings that emphasize customer awareness in adopting new banking technologies. Furthermore, Yan et al. (2022), Rodríguez-Espíndola et al. (2022), and Lapinskienė and Danilevičienė (2023) underscore the uptake of emerging technologies and their pivotal role in shaping the development of the banking industry, aligning with the research that establishes links between Fintech adoption, digital awareness, and green finance.

The studies conducted by Muganyi et al. (2021) and Guang-Wen and Siddik (2023) support the growing trend of combining Fintech solutions with finance initiatives. This aligns with this study's findings that highlight the impact of finance on the adoption of Fintech and digital transformation. Additionally, the perspectives shared by Udeagha and Muchapondwa (2023) and Liu et al. (2022) regarding the effects of Fintech and green financing on sustainability are in line with this study's findings on how the factors of green finance contribute to promoting banking practices. The research conducted by Udeagha and Ngepah (2023) and Mirza et al. (2023) further supports the findings demonstrating that the adoption of Fintech significantly influences the sustainability performance of banking firms. Finally, Nassiry (2018) and Bayram et al. (2022) offer insights into how Fintech advances finance, reinforcing the findings that digital transformation and awareness play crucial roles in moderating the relationship between Fintech adoption and green finance. The agreement between these results and the existing literature underscores the timeliness and relevance of our study in understanding sustainability dynamics, green finance, and Fintech within the banking industry.

5.1. Managerial and Practical Implications

One crucial lesson for the banking sector in Croatia is the importance of prioritizing awareness initiatives. It is essential for banks to invest in campaigns and user-friendly platforms to enhance their customers' understanding and comfort with banking tools. This emphasis on awareness has an impact on the adoption of Fintech services. By implementing

this strategy, banks cannot increase the rate at which Fintech services are adopted and also ensure that their customers are well prepared to utilize these services. This approach will facilitate a transition to banking for clients resulting in improved client retention and satisfaction.

The findings highlight the significance of integrating finance concepts into banking products and services. Croatian banks should consider developing and promoting products that support friendly initiatives, such as green loans and investments in sustainable projects. By catering to a segment of conscious customers, banks can enhance their market competitiveness while contributing toward broader sustainability goals. Aligning product offerings with the increasing consumer trend toward consciousness will be key.

Furthermore, recognizing the impact of Fintech adoption on banking sustainability emphasizes the need for banks to leverage Fintech to enhance customer experiences. This may involve implementing cutting edge mobile banking apps with functionality, sophisticated online payment systems, as well as utilizing AI and machine learning technologies, for personalized banking services.

By incorporating these technologies, banks can offer personalized services resulting in increased customer satisfaction and loyalty. This research emphasizes the importance of transformation in the banking industry even though it does not show an impact on the relationship between green finance and Fintech adoption. To stay competitive in the evolving market, banks should continue investing in innovation and digital infrastructure. This includes advancements and a shift in culture toward a digital-first approach.

To foster the growth of banking and green finance, collaboration among banks, Fintech companies, and regulatory agencies is crucial. Regulatory support is necessary to establish laws that encourage innovation while safeguarding user security and trust in platforms. Partnerships between Fintech firms and traditional banks can also lead to solutions that cater to evolving customer needs and sustainability goals. To summarize, the Croatian banking sector is in a phase where the implementation of these suggestions can have a major impact on customer satisfaction, growth trajectory, and sustainable financing.

5.2. Limitations and Future Directions

This study has limitations in terms of the sample size and demographic representation. While it provides insights based on the 304 respondents, it might not capture the entire customer base of the Croatian banking sector. The presence of a certain percentage of participants or a certain age range could potentially influence the results and make them less applicable to all demographic groups. Furthermore, because this study primarily focused on banking customers, it may have overlooked the perceptions and behaviors of customers who rely more on traditional banking due to limited digital access.

Another limitation is the sectional design used in this study. With this approach, the data are collected at a specific point in time. It might not reflect how customers' attitudes and behaviors evolve over time. Considering that the banking sector is constantly evolving with advancements such as Fintech and digital transformation, it would be beneficial to conduct studies that capture trends and long-term effects. Furthermore, while this study has focused on the factors of finance, digital awareness, and digital transformation, it has not considered all aspects related to Fintech adoption and banking sustainability. Factors such as customer trust, security concerns, technological infrastructure, and economic influences also play a role in shaping customer behavior toward Fintech solutions and digital banking.

To improve the generalizability, future research should focus on including a range with a larger sample size. This would involve incorporating participants from regions, income levels, and educational backgrounds into the study. By doing so, the study can gain a comprehensive understanding of the holistic factors that affect Fintech adoption and contribute to sustainable banking practices in Croatia.

In order to truly understand the evolution of Fintech and banking, it would be beneficial to conduct long-term research that captures their changing nature. By tracking these changes over time, we can gain insights into how customer attitudes toward banking and

green finance shift and ultimately impact the banking industry. It is important for future studies to consider factors such as customer trust, perceived security risks, economic conditions, and technological infrastructure. Additionally, exploring the influence of changes and government policies on Fintech can provide us with knowledge.

Author Contributions: Conceptualization, H.S. and M.P.; methodology, H.S.; resources, H.S., M.P. and Ž.Z.; writing—review and editing, M.P. and Ž.Z.; visualization, Ž.Z.; supervision, H.S.; All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

References

Abdul-Rahim, Ruzita, Siti Aisah Bohari, Aini Aman, and Zainudin Awang. 2022. Benefit–risk perceptions of Fintech adoption for sustainability from bank consumers' perspective: The moderating role of fear of COVID-19. *Sustainability* 14: 8357. [CrossRef]

Aboalsamh, Hoda M., Laith T. Khrais, and Sami A. Albahussain. 2023. Pioneering Perception of Green Fintech in Promoting Sustainable Digital Services Application within Smart Cities. *Sustainability* 15: 11440. [CrossRef]

Abuatwan, Nariman. 2023. The Impact of Green Finance on the Sustainability Performance of the Banking Sector in Palestine: The Moderating Role of Female Presence. *Economies* 11: 247. [CrossRef]

Barroso, Marta, and Juan Laborda. 2022. Digital transformation and the emergence of the Fintech sector: Systematic literature review. *Digital Business* 2: 100028. [CrossRef]

Bayram, Orkun, Isilay Talay, and Mete Feridun. 2022. Can Fintech promote sustainable finance? Policy lessons from the case of Turkey. *Sustainability* 14: 12414. [CrossRef]

Bryman, Alan. 2016. *Social Research Methods*. Oxford: Oxford University Press.

Chaudhuri, Atanu, Nachiappan Subramanian, and Manoj Dora. 2022. Circular economy and digital capabilities of SMEs for providing value to customers: Combined resource-based view and ambidexterity perspective. *Journal of Business Research* 142: 32–44. [CrossRef]

Chueca Vergara, Cristina, and Luis Ferruz Agudo. 2021. Fintech and sustainability: Do they affect each other? *Sustainability* 13: 7012. [CrossRef]

Corbet, Shaen, and Larisa Yarovaya. 2020. The environmental effects of cryptocurrencies. *Cryptocurrency and Blockchain Technology* 1: 149. [CrossRef]

Creswell, John W. 2014. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks: Sage Publications.

Danladi, Sagir, M. S. V. Prasad, Umar Muhammad Modibbo, Seyedeh Asra Ahmadi, and Peiman Ghasemi. 2023. Attaining Sustainable Development Goals through Financial Inclusion: Exploring Collaborative Approaches to Fintech Adoption in Developing Economies. *Sustainability* 15: 13039. [CrossRef]

Dapp, Thomas F. 2017. Fintech: The digital transformation in the financial sector. *Sustainability in a Digital World: New Opportunities Through New Technologies*, 189–99. [CrossRef]

Dash, Ganesh, and Justin Paul. 2021. CB-SEM vs. PLS-SEM methods for research in social sciences and technology forecasting. *Technological Forecasting and Social Change* 173: 121092. [CrossRef]

David-West, Olayinka, Nkemdilim Iheanachor, and Ikechukwu Kelikume. 2018. A resource-based view of digital financial services (DFS): An exploratory study of Nigerian providers. *Journal of Business Research* 88: 513–26. [CrossRef]

Dell'Erba, Marco. 2021. Sustainable digital finance and the pursuit of environmental sustainability. *Sustainable Finance in Europe: Corporate Governance, Financial Stability and Financial Markets*, 61–81. [CrossRef]

Duhnea, Cristina, and Georgiana-Loredana Schipor. 2021. The Fintech Industry in Romania—Assessing the Level of Acceptance for the Financial Services Consumers. *Ovidius University Annals, Economic Sciences Series* 21: 1013–22.

Elsinger, Helmut, Pirmin Fessler, Judith Feyrer, Konrad Richter, Maria Silgoner, and Andreas Timel. 2018. Digitalization in financial services and household finance: Fintech, financial literacy and financial stability. *Financial Stability Report* 35: 50–58.

Folwarski, Mateusz. 2021. The FinTech Sector and Aspects on the Financial Inclusion of the Society in EU Countries. *European Research Studies Journal* 24: 459–67. [CrossRef] [PubMed]

Fowler, Floyd J., Jr. 2014. *Survey Research Methods*. Thousand Oaks: Sage Publications.

Golubić, Gordana. 2019. Do digital technologies have the power to disrupt commercial banking? *InterEULawEast* 6: 83–110. [CrossRef]

Guang-Wen, Zheng, and Abu Bakkar Siddik. 2023. The effect of Fintech adoption on green finance and environmental performance of banking institutions during the COVID-19 pandemic: The role of green innovation. *Environmental Science and Pollution Research* 30: 25959–71. [CrossRef] [PubMed]

Gupta, Gaurav, Kevin Tee Liang Tan, Yaw Seng Ee, and Cynthia Su Chen Phang. 2018. Resource-based view of information systems: Sustainable and transient competitive advantage perspectives. *Australasian Journal of Information Systems* 22. [CrossRef]

Hair, Joseph F., Claudia Binz Astrachan, Ovidu I. Moisescu, Lăcrămioara Radomir, Marko Sarstedt, Santha Vaithilingam, and Christian M. Ringle. 2021. Executing and interpreting applications of PLS-SEM: Updates for family business researchers. *Journal of Family Business Strategy* 12: 100392. [CrossRef]

Hanafizadeh, Payam, and Hamid Reza Khedmatgozar. 2012. The mediating role of the dimensions of the perceived risk in the effect of customers' awareness on the adoption of Internet banking in Iran. *Electronic Commerce Research* 12: 151–75. [CrossRef]

Handro, Paul. 2018. The role of customer experience in retail bankingand the rise of Fintech. *Annals—Economy Series* 1: 175–85.

Haq, Muhibul. 2014. A Comparative Analysis of Qualitative and Quantitative Research Methods and a Justification for Adopting Mixed Methods in Social Research. *Annual PhD Conference, University of Bradford Business School of Management*. Available online: http://hdl.handle.net/10454/7389 (accessed on 8 November 2023).

Kamis, Arasinah, Ramdzan Ali Saibon, FaizalAmin Yunus, Mohd Bekri Rahim, Lazaro Moreno Herrera, and Pedro Luis Yturria Montenegro. 2020. The SmartPLS analyzes approach in validity and reliability of graduate marketability instrument. *Social Psychology of Education* 57: 987–1001.

Kasturi, Srini. 2023. Evolving consumer expectations and the future of digital banking. *The Journal of Digital Banking* 8: 37–48.

Lapinskienė, Giedrė, and Irena Danilevičienė. 2023. Assessment of Green Banking Performance. *Sustainability* 15: 14769. [CrossRef]

Leavy, Patricia. 2022. *Research Design: Quantitative, Qualitative, Mixed Methods, Arts-Based, and Community-Based Participatory Research Approaches*. New York: Guilford Publications.

Lee, In, and Yong Jae Shin. 2018. Fintech: Ecosystem, business models, investment decisions, and challenges. *Business Horizons* 61: 35–46. [CrossRef]

Liu, Hongda, Pinbo Yao, Shahid Latif, Sumaira Aslam, and Nadeem Iqbal. 2022. Impact of Green financing, Fintech, and financial inclusion on energy efficiency. *Environmental Science and Pollution Research* 29: 18955–66. [CrossRef] [PubMed]

Macchiavello, Eugenia, and Michele Siri. 2022. Sustainable finance and Fintech: Can technology contribute to achieving environmental goals? A preliminary assessment of 'green Fintech'and 'sustainable digital finance'. *European Company and Financial Law Review* 19: 128–74. [CrossRef]

Mavlutova, Inese, Aivars Spilbergs, Atis Verdenhofs, Andris Natrins, Ilja Arefjevs, and Tatjana Volkova. 2022. Digital transformation as a driver of the financial sector sustainable development: An impact on financial inclusion and operational efficiency. *Sustainability* 15: 207. [CrossRef]

Mejia-Escobar, Juan Camilo, Juan David González-Ruiz, and Eduardo Duque-Grisales. 2020. Sustainable financial products in the Latin America banking industry: Current status and insights. *Sustainability* 12: 5648. [CrossRef]

Mirza, Nawazish, Muhammad Umar, Ayesha Afzal, and Saba Firdousi Firdousi. 2023. The role of Fintech in promoting green finance, and profitability: Evidence from the banking sector in the euro zone. *Economic Analysis and Policy* 78: 33–40. [CrossRef]

Muganyi, Tadiwanashe, Linnan Yan, and Hua-Ping Sun. 2021. Green finance, Fintech and environmental protection: Evidence from China. *Environmental Science and Ecotechnology* 7: 100107. [CrossRef] [PubMed]

Nagy, Judith, Judith Oláh, Edina Erdei, Domicián Máté, and József Popp. 2018. The Role and Impact of Industry 4.0 and the Internet of Things on the Business Strategy of the Value Chain—The Case of Hungary. *Sustainability* 10: 3491. [CrossRef]

Namahoot, Kanokkan Snae, and Tipparat Laohavichien. 2018. Assessing the intentions to use internet banking: The role of perceived risk and trust as mediating factors. *International Journal of Bank Marketing* 36: 256–76. [CrossRef]

Náñez Alonso, Sergio Luis. 2023. Can Central Bank Digital Currencies be green and sustainable? *Green Finance* 5: 603–23. [CrossRef]

Nassiry, Darius. 2018. *The Role of Fintech in Unlocking Green Finance: Policy Insights for Developing Countries (No. 883)*. Asian Development Bank Institute Working Paper. Available online: https://www.adb.org/sites/default/files/publication/464821/adbi-wp883.pdf (accessed on 9 November 2023).

Nenavath, Sreenu, and Shashwat Mishra. 2023. Impact of green finance and fintech on sustainable economic growth: Empirical evidence from India. *Heliyon* 9. [CrossRef] [PubMed]

Omarini, Anna. 2017. The digital transformation in banking and the role of Fintechs in the new financial intermediation scenario. *International Journal of Finance, Economics and Trade* 1: 1–6. Available online: https://scidoc.org/articlepdfs/IJFET/IJFET-2643-038X-01-101.pdf (accessed on 9 November 2023).

Ozili, Peterson K. 2024. Dangers of Digital-Only Financial Inclusion. In *Business Drivers in Promoting Digital Detoxification*. Hershey: IGI Global, pp. 54–70. [CrossRef]

Pallant, Julie. 2020. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using IBM SPSS*. London: Routledge.

Rajkumar, Singh Ravins, Popat Ronak, Dhruv Dilip, Vipal Jha, Popat Parth, and Riddhi Joshi. 2020. A research study on awareness of fin-tech among millennial. *International Journal on Integrated Education* 3: 78–87.

Rasoolimanesh, S. Mostafa. 2022. Discriminant validity assessment in PLS-SEM: A comprehensive composite-based approach. *Data Analysis Perspectives Journal* 3: 1–8.

Rehman, Shafiq Ur, Mustafa Al-Shaikh, Patrick Bernard Washington, Ernesto Lee, Ziheng Song, Ibrahim A. Abu-AlSondos, Maha Shehadeh, and Mahmoud Allahham. 2023. Fintech Adoption in SMEs and Bank Credit Supplies: A Study on Manufacturing SMEs. *Economies* 11: 213. [CrossRef]

Ringle, Christian M., Marko Sarstedt, Rebecca Mitchell, and Siegfried P. Gudergan. 2020. Partial least squares structural equation modeling in HRM research. *The International Journal of Human Resource Management* 31: 1617–43. [CrossRef]

Ringle, Christian M., Sven Wende, and Jan-Michael Becker. 2022. *SmartPLS 4*. Oststeinbek: SmartPLS GmbH. Available online: https://www.smartpls.com (accessed on 15 November 2023).

Rodríguez-Espíndola, Oscar, Soumyadeb Chowdhury, Prasanta Kumar Dey, Pavel Albores, and Ali Emrouznejad. 2022. Analysis of the adoption of emergent technologies for risk management in the era of digital manufacturing. *Technological Forecasting and Social Change* 178: 121562. [CrossRef]

Roemer, Ellen, Florian Schuberth, and Jörg Henseler. 2021. HTMT2–an improved criterion for assessing discriminant validity in structural equation modeling. *Industrial Management and Data Systems* 121: 2637–50. [CrossRef]

Sarfraz, Muddassar, Zhixiao Ye, Doina Banciu, Florin Dragan, and Larisa Ivascu. 2022. Intertwining digitalization and sustainable performance via the mediating role of digital transformation and the moderating role of Fintech behavior adoption. *Studiesin Informatics Control* 31: 35–44. [CrossRef]

Shibin, K. T., Ramerhwar Dubey, Angappa Gunasekaran, Benjamin Hazen, David Roubaud, Shivam Gupta, and Cyril Foropon. 2020. Examining sustainable supply chain management of SMEs using resource based view and institutional theory. *Annals of Operations Research* 290: 301–26. [CrossRef]

Tamasiga, Phemelo, Helen Onyeaka, and El Houssin Ouassou. 2022. Unlocking the Green Economy in African Countries: An Integrated Framework of FinTech as an Enabler of the Transition to Sustainability. *Energies* 15: 8658. [CrossRef]

Udeagha, Maxwell Chukwudi, and Edwin Muchapondwa. 2023. Green finance, Fintech, and environmental sustainability: Fresh policy insights from the BRICS nations. *International Journal of Sustainable Development and World Ecology* 30: 633–49. [CrossRef]

Udeagha, Maxwell Chukwudi, and Nicholas Ngepah. 2023. The drivers of environmental sustainability in BRICS economies: Do green finance and Fintech matter? *World Development Sustainability* 3: 100096. [CrossRef]

Yadav, Uma Shankar, Ravindra Tripathi, and Mano Ashish Tripathi. 2022. Effect of Digital and Financial Awareness of Household Womens on the Use of Fin-Tech in India: Observing the Relation with (Utaut) Model. *Journal of Sustainable Business and Economics* 5: 18–26. [CrossRef]

Yan, Chen, Abu Bakkar Siddik, Li Yong, Qianli Dong, Guang-Wen Zheng, and Md Nafizur Rahman. 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: 148. [CrossRef]