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Research article

Adoption of green banking innovations: Drivers and outcomes

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Abstract: The shift toward environmentally sustainable finance has placed increased pressure on banks, especially in emerging economies, to align operations with global climate goals. Jordan's banking sector faces unique institutional, regulatory, and societal expectations, creating a timely need to investigate the mechanisms driving and resulting from the adoption of green banking. This study empirically investigates the drivers and outcomes of adopting green banking innovations within Jordan's financial institutions. Focused on key factors such as regulatory pressure, corporate social responsibility (CSR) orientation, operational efficiency, global green trends, and market demand for green products, the research examines how these elements influence the integration and effectiveness of green banking practices. Data were collected from senior executives and managers across various banks in Jordan, with 217 validated responses utilized for analysis. Smart partial least squares software for hypothesis testing was applied. The findings reveal that regulatory pressures, CSR orientation, and global green trends significantly promote the adoption of green banking innovations. Furthermore, the results demonstrate that green banking practices significantly enhance operational efficiency and contribute to environmental sustainability. The study underscores the importance of a strategic commitment to environmental principles in the banking sector, emphasizing how such commitments facilitate operational improvements and support broader sustainability goals. This research contributes to an understanding of how banks in emerging economies, like Jordanian banks, can adopt sustainable practices and enjoy financial and environmental benefits. The study implications are that regulators and banks must enhance their green policies and practices to ensure sustainability in the financial sector.

Keywords: green banking; regulatory pressure; corporate social responsibility; operational efficiency; environmental sustainability; financial institutions

1. Introduction

The world's economy is dramatically changing as countries strive to balance economic expansion with environmentally sustainable practices (Sachs et al., 2019). The impact of climate change has increased pressures for businesses to adopt eco-friendly practices, creating space for the banking industry to act as a crucial driving force for this green shift (Falcone et al., 2018). Both academics and practitioners have increasingly focused on greener practices in banking, which can be defined as integrating environmental considerations into core operational processes, financial services, and investment approaches (Aslam & Jawaid, 2023). The use of green banking more broadly helps in solving environmental issues, while, at the same time, the company can improve its performance, avoid regulations, and satisfy the needs of a target market that requires green loans (Park & Kim, 2020).

There are a variety of drivers on the global scale that create the need to implement green banking features. The authorities' regulations and environmental policies are becoming more and more stringent; therefore, it is mandatory for a financial institution to be sustainable (Hussain et al., 2024). For example, there are operational needs which range from carbon taxes, emissions limits, and environmental report requirements, which result in the incorporation of green concepts into banks' strategies (Thanasas, 2024; Kasasbeh et al., 2022). In addition, corporate social responsibility (CSR) has been on the rise in business ethics, and stakeholders have been pushing for better stewarding and reporting of environmental aspects; this has become a primary business requirement. Green banking is a natural aspect of CSR, as it highlights a bank's decision to practice environmental conservation and do business in an ethical way (Alshehadeh et al., 2022).

Increased operational efficiency and adoption of green banking innovations were also mentioned by Aslam and Jawaid (2023). Banks are able to achieve these goals through modern means, including digital and paperless operations. The impact is not only a reduction in expenses by the banks but also a very large reduction in the carbon footprint (Goel, 2022). The paradigm shift has also been facilitated through the internalization of world environmental trends championed by global regimes such as the Paris Climate Accord. As a result, the banks are now under pressure to come up with new ideas on methods to make money while reaching for the goals of sustainability, which include green bonds, renewable energy loans, and eco-friendly savings accounts (Cochran & Pauthier, 2019).

The current market is already placing an emphasis on sustainability, which increases the need for green banking innovations (Sun et al., 2020). With greater social responsibility, more and more consumers and businesses are looking for services that do not harm nature. Due to this change in the behavior of the consumers, banks have had to modify their products, designing those that will have a lesser negative impact on the environment (Bansal et al., 2024). In so doing, the banks not only meet the current market demands but do so in a way that makes them attractive to their clients in an increasingly competitive world (Alsmadi et al., 2023a).

The benefits of implementing green banking do not end solely with concern for the environment. Green banking adds value to the market and enhances the overall brand because it includes ecofriendly customers and has ecofriendly partners (Ibe-enwo et al., 2019). Furthermore, these actions promote monetary performance in the long run by avoiding the risks of environmental responsibilities,

compliance with regulations, and negative publicity. The sustainability of the environment, as one of the outcomes, indicates the level of environmental concern of a bank and what it is doing to affect climate change (Al-Gasaymeh et al., 2023).

The implementation of green banking technologies does not come easily, despite their readily recognizable merits. Financial institutions are constrained by high implementation costs, a change of paradigm, and the absence of defined practices for measuring the success of the green initiatives put in place (Alzoubi et al., 2022; Bouteraa et al., 2023). In addition, the diversity in regulatory requirements by different jurisdictions also hinders banks from applying a uniform approach to various green initiatives. These difficulties call for strategic investigations to understand what drives the implementation of such green banking innovations in the financial industry and how their implementation impacts the financial industrial sector (Bouteraa et al., 2021).

This research paper seeks to address these gaps by investigating the drivers and outcomes of adopting green banking innovations. The study aims to provide a holistic understanding of the factors that motivate financial institutions to embrace sustainable practices and the tangible benefits that result from such initiatives. Specifically, it focuses on key drivers such as regulatory pressure, CSR orientation, operational efficiency, global green trends, and market demand for green products. The paper also examines the outcomes, emphasizing environmental sustainability and market competitiveness. To guide this investigation, the following main research question has been formulated: "What are the key drivers and outcomes of adopting green banking innovations in financial institutions?"

In addition, this research contributes to the broader green banking innovations debate by providing a comprehensive analysis of the drivers and implications for the adoption of green banking practices in a single regional example, namely Jordan. Although much research focuses on developed countries, the present research provides an opportunity and challenge to analyze the adoption of sustainability in banking practices in an emerging economy. By examining the manner in which regulatory pressures, CSR orientation, market demand, and global green trends interlink in driving the adoption of green bank innovations, the study shows how all the elements above synergistically drive the adoption of the green banking innovations. The study also develops a novel conceptual model of thought concerning the adoption of green innovations, which will lead scholars and policymakers in the proper way of fostering green practice within banks across the globe. Towards these efforts, the study presents significant theoretical advances in the knowledge around green banking innovations, especially for developing economies.

The present research adds to the literature on sustainable finance through aiming to understand the factors which enable green banking innovations to bring about changes in the financial industry. This research, in addition to increasing our theoretical knowledge through identifying the main drivers and their outcomes, also has practical lessons for policy makers, financial institutions, and all stakeholders who aim to foster sustainability in their banking activities. In addition, the findings seek to encourage financial institutions to transcend the current limitations and embed green innovations in their strategic frameworks.

2. Theoretical background

Several theoretical models have been developed to analyze the factors promoting the uptake of green banking innovations, as well as their effects. As a result, it is important to examine the economic structure of financial institutions from these three perspectives: institutions, stakeholders, and

resources. According to institutional theory, institutional isomorphism and varying structures also influence the extent to which organizations comply with the environment (Verver & Dahles, 2015). They say that all organizations exist in environments, and this makes them seek legitimacy by crafting institutional policies that enable them to conform to the requirements from the world around them. Firms are also forced to follow certain standards set by the state and its organizations in pursuing their organizational goals according to institutional logic (López-Cabrales, 2011). As a practical matter, however, regulatory pressures, such as emissions standards, carbon taxes, and sustainability reporting, create pressure for the banks and financial institutions in integrating innovations that are environmentally friendly (Jarah et al., 2024; Stewart et al., 2020). In addition to this, obligations imposed by overarching global green trends and international agreements such as the Paris Climate Accord ensure that the understanding of sustainability goals within the banking sector is the same (Wang et al., 2020).

Another viewpoint is the stakeholder theory, which stresses that a firm must also focus on the needs and expectations of a variety of constituents such as customers, investors, employees, and communities (Sarwar, 2023). Any investor or other stakeholder expects disclosure and an assurance of responsibility regarding environmental issues from corporations and will urge banks to integrate green banking changes in compliance with their CSR policies. Through these, banks are able to enhance trust, boost their brand reputation, and appeal to clients and investors that are eco-friendly (D'Este, 2024). Stakeholder theory, in turn, points out the benefits of investing in green banking policies in terms of creating better relations with clients and improving the image of the organization (Abu-AlSondos et al., 2024).

The resource-based view (RBV) adds to the understanding of these banks and focuses on their internal capabilities and resources. According to the RBV, banks that efficiently utilize their advanced technology, infrastructure, and capital resources to execute green transformation will outperform their competitors (Probojakti et al., 2024). For example, better banking resources can allow digital operations instead of paper-based processes, which cause more expense and are less environmentally friendly. These advancements not only make for efficient time management but also give a competitive edge. The RBV explains how the effective use of internal resources makes the adoption of green banking initiatives possible, with a greater prospect of long-term benefits for the organization (Sahioun et al., 2023).

This current study extends existing research by implementing proven theories in the context of green banking. Although previous studies have employed institutional theory, stakeholder theory, and the RBV of organizational behavior in traditional banking, this study applies these theories specifically to analyze the adoption of green banking innovations in the Jordanian banking sector. Specifically, we extend institutional theory by incorporating a "green institutional isomorphism" factor, wherein international environmental trends and regulatory pressures not only drive conformity but also promote green banking innovations. Also, through integration of the competitive advantage theory with CSR orientation, we propose the idea that CSR in green banking is not only a defensive necessity but also an entrepreneurial asset creating a sustainable competitive advantage in emerging markets. The study's contextual strategy of focusing on Jordan, a developing nation with special regulatory and socio-cultural conditions, offers new insights into how global green trends converge with local institutional concerns, thus adding a unique contribution to sustainable banking theory.

3. Literature review and development of hypotheses

3.1. Regulatory pressure and adoption of green banking innovations

The interplay between regulatory pressure and the diffusion of green banking has been very interesting within the field of sustainable finance (Bose et al., 2021; Park & Kim, 2020). Khan et al. (2021) identified that regulatory pressure, which embodies procedures linked to environmental policies, carbon emissions levels, and sustainability reporting requirements, is an external force that moves financial institutions to embrace green banking. Jain et al. (2022) argued the opposite idea, explaining that regulatory frameworks help to propel banks to use green financial products, such as green bonds and renewable energy loans. They help banks, nongovernment organizations (NGOs), and other financial institutions meet their environmental targets and still work within the legal confines. In the same vein, Dong et al. (2021) argued that sustainability reporting obligations encourage banks to harness technologies such as digital banking and the use of paperless transactions. A study by Zhang (2023) shows that banks can be motivated to seek energy-efficient pathways through measures such as carbon taxes, which create market-based tools to do so. They concluded that this type of regulation forms the basis for compliance, but also spurs ingenuity within the banking industry. Light and Skinner (2021) reported an analogous finding. For them, it is also evident that international pacts, such as the Paris Climate Accord, become normative mechanisms which push banks to incorporate green practices in their business strategy. The need for sustainable approaches toward risk management also appears as a legal requirement, according to Korkmaz (2022), which can influence the adoption of such frameworks. This finding was also confirmed in the research of Wahyuni et al. (2024), who found that the more stringent the environmental regulations applied, the higher the investment in green banking technologies. On the basis of all this, the following can be assumed:

H1: Regulatory pressure significantly impacts the adoption of green banking innovations.

3.2. CSR orientation and adoption of green banking innovations

There is a growing synergy between ethical business activities and environmental sustainability and the relationship between an orientation towards CSR and willingness to adopt greening innovations in the operations of the banking industry (Gazi et al., 2024). An orientation towards CSR represents the selflessness of organizations in pursuing the interests of the people or saving the environment, which is quite often achieved using various approaches including greening approaches; in this case, green banking (Sun et al., 2020). According to Park & Kim (2020), organizations with strong commitments to CSR, such as financial institutions, will engage in greening banking practices to conserve the environment. The possibility to change society for the better through such means has been proposed by many scientists, suggesting that CSR-oriented banks allocate their assets to environmentally friendly technologies and products. In the same regard, Manoj and Kumari (2023) noted that energy-efficient operations and decreased paper consumption are more likely to be achieved through a group's CSR orientation. A firm investigation by Sarfraz et al. (2023) confirmed that initiatives concerning both single and multiple dimensions of CSR are the initial preconditions for launching green financial products, including green bonds and loans for renewable energy projects. As a result of these activities, banks can portray themselves as environmentally friendly and responsible

institutions that meet the needs of investors who care about the environment. In contrast, banks that profess CSR principles are more likely to work with environmentally sound companies, thereby promoting the process of greening the banking sector. In 2024, Alshukri et al. investigated the impact of CSR on organizational culture and internal organizational processes, noting that a high CSR orientation leads to self-driven efforts towards innovativeness of a sustainable kind. This is in line with Altenburger (2018), who stated that engagement in CSR improves a bank's market image and allows them to extend the range of green solutions reasonably to maintain their competitive edge. Furthermore, Sharma et al. (2024) reported that banks that have more strategic approaches to CSR consider the usage of green banking innovations as a differentiation tool in aggressive market environments. On the basis of all this, the following can be assumed:

H2: CSR orientation significantly impacts the adoption of green banking innovations.

3.3. Global green trends and adoption of green banking innovations

Global environmental (green) trends have had a major effect on the development of green banking innovations due to the global environmental knowledge and practices that aim to enhance sustainable business operations (Bouteraa et al. 2021). Kulińska-Sadłocha (2022) underscored that such agreements give rise to the imposition of normative pressures on banks to engage in green banking practices. They create obligations, thereby enabling and enticing financial institutions to enforce strategies to address the global risk. In the same context, Khan & Johl (2019) pointed out that the praiseworthy aim of improving the encaging strategies of the banks focused on by ISO 14001 and other international green certificates contribute further policy alternatives for banks' expansion, focusing on green innovations. A study conducted by Shinde (2021) examined consumers' green trends and reported that there is a rising demand for green bonds and renewable energy financing among customers who are becoming increasing environmentally conscious. Therefore, there is a market for these banks to create products to meet this environmental demand. In addition, Sun et al. (2020) stated that with the help of international environmental risk factors, banks with green brands have higher brand equity than their rivals, which helps them to become competitive leaders of the green economy. Furthermore, Singh et al. (2023) investigated the correlation between global green technological development and the development of the banking industry, with the swift incorporation of energy-efficient systems and shifting to the use of paperless processes being typical phenomena. Such findings were corroborated by Khaer and Anwar (2022), who noted that there is a positive correlation between the emergence of technological innovations at the global level and the introduction of new green banking technologies. On the basis of all this, the following can be assumed:

H3: Global green trends significantly impact the adoption of green banking innovations.

3.4. Market demand for green products and the adoption of green banking innovations

Sharma et al. (2024) pointed out that environmental education among the consumers has raised their expectations concerning green finances, such as renewable energy loans or eco-friendly savings. In turn, such consumers will be attracted to competitors who adopt green banking innovations to address such demands. In the same light, Mohd and Kaushal (2018) observed that more business clients are now turning to financial institutes providing green bedding options which, in turn, compels the

banks to provide sustainable market innovations. Bouteraa et al. (2021) stressed that green banking innovations are not only influenced by the environmental issues but also by the paying capability of the customers for sustainable promotional items. This trend enables banks to create new products such as green bonds and low-carbon credit cards in order to take advantage of this market. In support of this viewpoint, Stauropoulou et al. (2023) revealed that commercial banks providing services addressing the sustainable development goals find that this helps in gaining customer loyalty and enhancing their brand image (Chen et al., 2021). Additionally, Chien et al. (2021) noticed that small and medium enterprises (SMEs) with a strong focus on sustainable practices are important sources of demand for green banking products, which calls for new banking solutions. Rodrigues and Franco (2023) argued that this need is greater than simply the financial sphere, causing banks to incorporate new technologies, such as digital infrastructure and a lack of paper, within their environmental strategies. Others, including Gangi et al. (2019), suggested that the demand in the market drives the integration of banks and those dealing with ecological matters, thus enabling the joint generation of eco-friendly financial products. On the basis of all this, the following can be assumed:

H4: Market demand for green products significantly impacts the adoption of green banking innovations.

3.5. Adoption of green banking innovations and operational efficiency

It is increasingly argued that the correlation between the adoption of green banking innovations and operational efficiency is one of the key issues of the sustainable development of finances (Aslam & Jawaid, 2023). Green banking is characterized by a number of elements, such as paperless banking, which lead to the improved internal efficiency of financial institutions (Rehman et al., 2021). Awan (2023) maintained that with the introduction of solutions for digital banking, the dependency on paper banking processes is negated; hence, considerable cost and operational benefits are realized. Banks enhance convenience and reduce resource depletions by shifting to online services and e-statements, and thus improve efficiency. Along the same lines, Mallo et al. (2024) pointed out that green innovations, like the deployment of technology in banking processes and automated systems, save banks time by reducing the need for labor. In the same way, Esho et al. (2024) drew attention to the impact of energy-efficient structures upon the operational costs of businesses. Some benefits of putting up solar panels and employing energy-efficient tools include reduced electricity expenditure as well as conservation of the environment. Adeniran et al. (2024) established that the utilization of environmentally friendly technology in these processes enhances risk management through a reduction in environmental and regulatory penalties. Hussain et al. (2024) witnessed that innovations in green banking make it possible for resources to be optimized, thus enabling banks to be able to use the resources saved for other important business areas and encouraging innovations. Furthermore, Nwosu et al. (2024) observed that the operational efficiency which comes from green strategies has a positive impact on customer experience, as digital and paper-free systems promote better speed and precision in the provision of services, and this result is supported by others (Al Omoush et al., 2023; Bataineh et al., 2024; Yaseen & Al Omoush, 2020). On the basis of all this, the following can be assumed:

H5: Adoption of green banking innovations significantly impacts operational efficiency.

3.6. Adoption of green banking innovations and environmental sustainability

The use of green banking innovations is quite significant, since such firms would incorporate their banking activities with protecting the environment (Al-Omari et al., 2024; Khaer & Anwar, 2022; Mohammed et al., 2024). According to Zhang et al. (2022), introducing green banking innovations is effective in decreasing the negative environmental consequences of conventional banking practices. According to their findings, 'decreasing paper use and using paperless systems, e-statements, and online transactions contribute to reducing logging as well as reducing waste generation that, in the long run, is beneficial to the ecology'. Such is the case with Lee (2020), who has also explained the importance of green financing concepts in contributing to healthy communities and economies in the years to come. It is good to know that green banking practices enable investment development in eco-friendly projects like renewable energy by adopting stronger environmental protection measures and creating a multiplicative effect. How investment in energy saving technologies like solar-powered devices and solar-powered bank branches promote energy efficiency and bring down carbon emissions by banks was also documented by Bangladesh Bank (2020). Thus, the direction towards which these businesses are switching is more carbon-cautious and participates greatly in the fight against climate change while being able to set an example for other sectors within the economy. In support of this point, David & Venkatachalam (2018) reaffirmed in their study that adopting green banking policies enhances investment and development in green infrastructure and consequently has a positive impact on the environment. As Gulzar et al. (2024) explained, the adoption of green banking principles accelerates corporate environmental responsibility and puts forth banks as major actors in implementing global sustainability objectives. In addition, Bansal et al. (2019) were of the view that green banking ideas, such as green loans and green bonds, are offered by financial institutions with a view towards financing environmentally sound ventures. In a similar vein, Prabhu and Aithal (2023) noted that the adoption of green banking principles looks for environmental solutions through reducing waste and pollution. On the basis of all this, the following can be assumed:

H6: The adoption of green banking innovations significantly impacts environmental sustainability.

## 3.7. Adoption of green banking innovations and market competitiveness

Recently, the implementation of green banking innovations has become a way to create more competitive positioning within the financial market sector through adopting these environmentally friendly practices (Hidayat-ur-Rehman & Hossain, 2024). Sharma et al. (2024) argued that customers are attracted to banks that adopt green initiatives because such banks offer eco-friendly products and have sustainable investment portfolios. Such innovations respond to the market preferences of both business and individual consumers who desire sustainable financial services. According to Taghizadeh-Hesary and Yoshino (2020), banks strengthen their market position by improving their corporate image through embracing progressive practices such as providing renewable energy loans and issuing green bonds. Javid et al. (2023) showed that due to the trust and goodwill generated through green banking innovations, there is increased customer loyalty towards the financial institutions offering these products/services. Their research showed that customers are more willing to bank with environmentally conscious entities that have a more innovative approach to business. Further, green banking practices help such banks to become first in the industry through first-mover advantages,

thereby commanding large market shares as the benchmark (Fahima 2023) for the other market players to follow. Shershneva and Kondyukova (2020) stated that the implementation of green banking brings about a reduction in operation costs through energy savings and paperless banking systems, and thus the costs saved can be redirected to competitive strategies. This operational efficiency enhances the profitability for the firm in the long run, and this is important so that the firm is able to maintain its presence in the market, not only for today but for the years to come (Bose et al., 2018). Meanwhile, Prabhu (2021) was able to conclude that green banking expands its scope through new opportunities like carbon credits and eco-savings accounts. On the basis of all this, the following can be assumed:

H7: Adoption of green banking innovations significantly impacts market competitiveness.

Figure 1 illustrates the research model and proposed connections among the study variables, which have been previously discussed and justified in the preceding subsections.
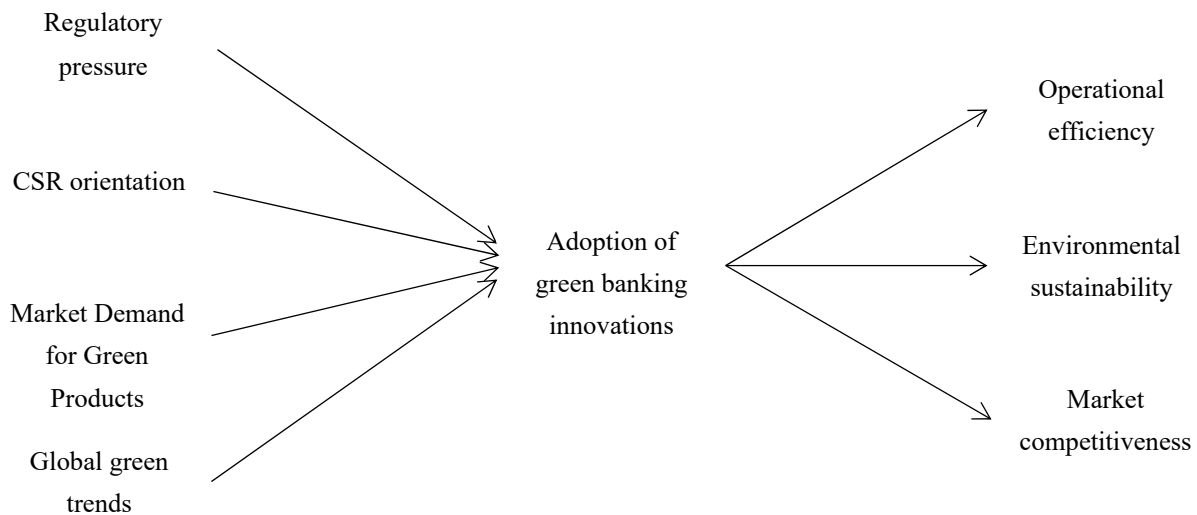
Figure 1. The research model.

4. Research methodology and data analysis

4.1. Sampling and data collection

Given the study's objectives, it was logical to target the banking sector to collect data. Banks are central to financial systems, and their role as financial intermediaries positions them as crucial players in adopting green innovations. They manage large pools of capital and can influence sectors by directing financing toward sustainable projects, a key green banking dimension. Banks can help foster the development and adoption of green technologies by providing loans, investment products, and financing solutions for environmentally friendly projects. Therefore, green innovation in the banking sector can be considered a rich area for study, as it incorporates traditional banking with sustainability-oriented innovations and encourages other financial institutions to pay more attention to green strategies and contributions to sustainability growth.

In recent years, there has been a general trend toward adopting more sustainable practices across various economic sectors, including the banking sector (Bose et al., 2018). In Jordan, financial institutions are increasingly interested in adopting green banking practices that align with global environmental goals. As part of its efforts to support financial sustainability and green financing in the banking sector, the Association of Jordanian Banks recently developed environmental and social governance (ESG) standards and enhanced green financing tools in the banking sector. These efforts came in response to the green finance strategy 2023–2008, launched by the Central Bank of Jordan. This strategy is part of the bank's efforts to address climate change risks and keep pace with the best and latest practices in green financing for environmentally friendly investments and projects that mitigate the impact of climate change on the national economy. This strategy is the first of its kind in the Middle East and North Africa region, having been prepared in collaboration with the World Bank and in coordination and partnership with the banking and financial sectors and relevant entities in the public and private sectors, with funding from the Jordan Multi-Donor Trust Fund for Inclusive Growth and Economic Opportunity. However, the Association of Jordanian Banks established the Green Finance Forum, the first session of which was held in mid-2023.

Banks have the option of responding online as well as through paper-based questionnaires. The sample included senior executives, managers, and specialists in sustainability, green finance, operations, product/service development, investment, CSR, customer services, marketing, risk management, compliance, information, and technology, as well as branch managers. The data were collected between 25 August and 30 September 2024. In total, 217 validated questionnaires were used for analysis. The profile of the participants is shown in Table 1. A widely used minimum sample size estimation method in partial least squares structural equation modelling (PLS-SEM) is the 10-times rule method (Hair et al., 2011). The assumption is that the sample size should be greater than 10 times the maximum number of inner or outer model links pointing to any latent variable in the model. According to this equation, the sample size of this study is more than sufficient to achieve reliable results.

Table 1. The participants' profiles.

Sample characteristics	Respondents	%
Gender		
Male	142	65
Female	75	35
Age (years)		
<30	48	22
30–45	76	35
>45	93	43
Experience (years)		
<10	36	17
10–20	97	45
>20	84	39
Education		
Diploma or less	43	0.20
Bachelor	118	0.54
Postgraduate	56	0.26
Total	217	100

4.2. Instrument development

As shown in Table 2, the questionnaire items were derived from reliable research sources and previous studies on regulatory pressure, CSR orientation, market demand for green products, global green trends, operational efficiency, environmental sustainability, market competitiveness, and the adoption of green banking innovations. Moreover, the sources of these measure have been presented in Table 2 for the sake of ensuring this study's validity and the reliability of the constructs. These constructs have all been grounded in previous green banking and sustainable finance studies. From these previous research works, we can provide assurances that the items discussed in the questionnaire are drawn from previous scholarly literature and tested for strength as well as applicability.

Table 2. Sources of measurement.

Constructs	References
Regulatory pressure	Liao (2018); Vazou et al. (2021)
CSR orientation	Holtbrügge and Oberhauser (2019); Du Preez and Van Zyl (2015)
Market demand for green products	Lin et al. (2013); Kumar and Ghodeswar (2015)
Global green trends	Čekanavičius et al. (2014)
Operational efficiency	Kareem et al. (2019)
Environmental sustainability	Dikken et al. (2023); Drews and van den Bergh (2016)
Market competitiveness	Pavlenchyk et al. (2021); Dvouletý and Blažková (2021)
Adoption of green banking innovations	Aslam and Jawaid (2023); Bouteraa et al. (2023)

*This table shows the sources of measurement.

The questionnaire, which includes 30 items, as shown in Table 3, was revised by three experts in the field of the current study on the basis of their frequency, importance, consistency, relevance, and clarity, and to reduce any potential bias in its items.

Table 3. Questionnaire items.

Constructs	Code	Statements
Regulatory pressure	RP1	Our organization complies with all government-mandated environmental regulations.
	RP2	Regulatory requirements have influenced our adoption of green banking innovations.
	RP3	Compliance with sustainability laws is a top priority for our organization.
	PR4	We face significant regulatory pressure to reduce our environmental impact.
CSR orientation	CSRO1	Our organization actively promotes environmentally friendly practices as part of our CSR initiatives.
	CSRO2	Corporate social responsibility drives our decisions to adopt green banking solutions.
	CSRO3	We allocate resources to projects that benefit the environment and society.
	CSRO4	Our CSR commitments include efforts to enhance sustainability in banking operations.
Market demand for green products	MDGP1	There is a growing demand from customers for environmentally friendly banking products.
	MDGP2	Green financial products enhance customer satisfaction and loyalty.
	MDGP3	We prioritize designing products that meet the needs of eco-conscious clients.
	MDGP4	Market trends toward sustainability influence our product development strategies.
Global green trends	GGT1	International agreements on climate change influence our environmental strategies.
	GGT2	Global trends in green technology inspire our adoption of eco-friendly practices.
	GGT3	Our green initiatives align with global sustainability goals like the Paris Agreement.
	GGT4	We monitor international best practices to improve our environmental performance.
Operational efficiency	OE1	Green banking innovations have enhanced our operational efficiency.
	OE2	Implementing paperless processes has reduced operational costs significantly.

Constructs	Code	Statements
Operational efficiency	OE3	Energy-efficient technologies have improved the overall performance of our operations.
	OE4	Digital banking solutions have streamlined our services and reduced resource use.
Environmental sustainability	ES1	Our organization actively reduces its carbon footprint through green banking initiatives.
	ES2	Environmental sustainability is a key goal in our business operations.
	ES3	We invest in projects that promote renewable energy and eco-friendly practices.
Market competitiveness	MC1	Adopting green innovations enhances our competitive position in the market.
	MC2	Customers prefer banks that offer environmentally sustainable products.
	MC3	Green banking initiatives have improved our brand reputation and market share.
Adoption of green banking innovations	GPI1	Our organization is committed to integrating green innovations into our banking operations.
	GPI2	We have successfully implemented green financial products like green loans and bonds.
	GPI3	Green banking initiatives are an essential part of our strategic goals.
	GPI4	Employees are encouraged to support and innovate in green banking practices.

* This table shows the questionnaire items (source: Authors' own creation).

The respondents rated each item on a Likert scale from 1 (strongly disagree) up to 5 (strongly agree). The validation method proposed by Kock (2015) was used to check for common method bias (CMB) resulting from the use of the same source or method in data collection. The results showed that this bias had no significant effect, as the variable's inflation factor (VIF) values for all items exceeded 3.3.

4.3. Data analysis

In this research, smart partial least squares (Smart PLS) version 4 was utilized to conduct structural equation modeling (SEM) path model procedures. For testing a structural model and hypothesis testing, the software is very efficient because it is utilized to estimate research models, e.g., scales of measurement of validity and reliability (Hair et al., 2017). Smart PLS is very proficient in analyzing structural models and equations and is very flexible when dealing with complex interdependencies between and among variables (Sarstedt et al., 2014). Smart PLS is also appropriate for relatively small sample sizes and is very handy when dealing with field studies with fewer respondents (Hair et al., 2017). Smart PLS is also still appropriate for dealing with latent variables, which are very significant in representing and measuring multidimensional constructs. Nonetheless, the smart PLS estimates can turn out to be imprecise when the wrong type of data are used (Nam et al., 2020). Also, strict adherence to the guidelines of the method is required because noncompliance may cause invalid outcomes and unreliable conclusions (Duarte & Amaro, 2018). The software is also problematic when analyzing models with a large volume of factors or complex interdependencies, which might complicate interpretations (Sarstedt et al., 2014).

4.4. Model assessment

The research began with an examination of the fit among the items and corresponding constructs by factor loadings, one of the key measures of reliability and validity. According to the PLS results, all the measurement items loaded significantly with a loading greater than the lowest acceptance limit

of 0.60 except two items, which were hence dropped from the later analysis. They were one of the items of the regulatory pressure construct (PR3) and the other was one of the market demand for green products construct (MDGP2). To further test for the internal consistency and reliability of each construct's items, Cronbach's alpha (α) and composite reliability (CR) were computed, based on the minimum acceptance threshold value of 0.70. Convergent validity was also tested by the average variance extracted (AVE), which is the ratio of the proportion to which the variance of indicators is explained by the construct to the measurement error, with an ideal cutoff value of 0.50. As seen in Table 4, all the constructs yielded Cronbach's α and CR values greater than the acceptable values (Hair et al., 2017), and the AVE values were also greater than 0.50.

Table 4. Validity and reliability.

Constructs	Cronbach's alpha	CR	AVE
Adoption of green banking innovations	0.835	0.862	0.673
CSR orientation	0.815	0.820	0.642
Environmental sustainability	0.763	0.776	0.676
Global green trends	0.797	0.798	0.621
Market demand for green products	0.893	0.893	0.823
Market competitiveness	0.758	0.776	0.674
Operational efficiency	0.843	0.848	0.683
Regulatory pressure	0.761	0.786	0.675

*This table shows the validity and reliability (Source: Authors' own creation).

To assess the discriminant validity of the measurement, Fornell and Larcker's (1981) criterion was adopted.

**Table 5**. Discriminant validity.

No	Constructs	1	2	3	4	5	6	7	8
1	Adoption of green banking innovations	0.820							
2	CSR orientation	0.536	0.802						
3	Environmental sustainability	0.417	0.433	0.822					
4	Global green trends	0.593	0.415	0.572	0.788				
5	Market demand for green products	0.492	0.393	0.392	0.618	0.907			
6	Market competitiveness	0.478	0.384	0.630	0.572	0.563	0.821		
7	Operational efficiency	0.569	0.528	0.462	0.607	0.452	0.475	0.826	
8	Regulatory pressure	0.676	0.531	0.515	0.566	0.456	0.512	0.612	0.822

*This table shows the discriminant validity (source: Authors' own creation).

The results of Smart PLS, as shown in Table 5, confirm the discriminant validity of all research constructs, as the square root of each AVE coefficient of each construct exceeded the correlation between the constructs.

4.5. *The Structural Model*

The outcome of Smart PLS (Figure 1) indicates that regulatory pressure, CSR orientation, market demand for green products, and global green trends account for 55.6% of the variance in the adoption of green banking innovations.
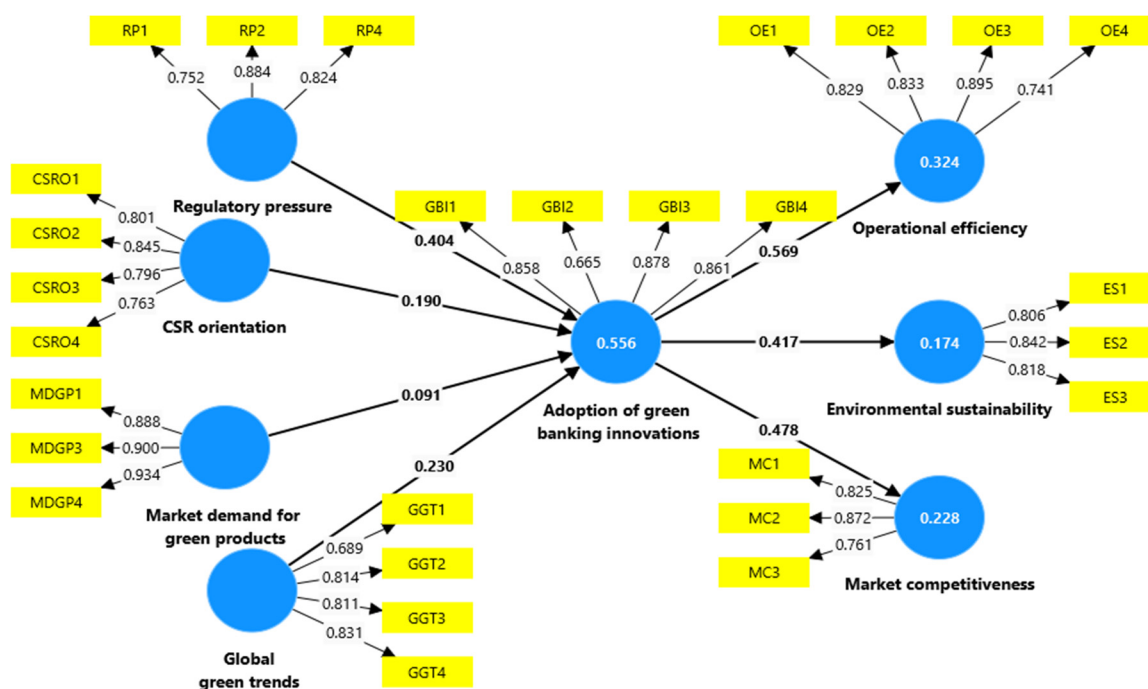
Figure 2. Path coefficient analysis.

More details on the outcome of the PLS path analysis are provided in Table 6. Following Hair et al. (2017), path coefficients > 0.1 and t-values > 1.96 with p-values < 5% are regarded as statistically significant. Table 6 demonstrates that regulatory pressure (H1) and CSR orientation (H2) significantly impact the adoption of green banking innovations (H1). The path coefficients of the relationships were 0.404 ($p = 0.000$) and 0.190 ($p = 0.007$), respectively, with t-values > 2 for both relationships. The study did not find a significant impact of the market demand for green products (H3). At the same time, it indicated that global green trends (H4) significantly impact the adoption of green banking innovations. The path coefficient was 0.230 ($p = 0.004$), with t-values > 2.

Table 6. Hypotheses testing.

Paths	Original sample	T statistics	P-values
Regulatory pressure → adoption of green banking innovations	0.404	5.668	0.000
CSR orientation → adoption of green banking innovations	0.190	2.688	0.007
Market demand for green products → adoption of green banking innovations	0.091	1.286	0.199
Global green trends → adoption of green banking innovations	0.230	2.886	0.004
Adoption of green banking innovations → operational efficiency	0.569	11.759	0.000
Adoption of green banking innovations → environmental sustainability	0.417	7.297	0.000
Adoption of green banking innovations → market competitiveness	0.478	8.690	0.000

*This table shows the results of hypotheses testing (source: Authors' own creation).

The results reveal that the adoption of green banking innovations significantly impacts operational efficiency (H5) and environmental sustainability (H6). The path coefficients of relationships were 0.569 ($p = 0.000$) and 0.417 ($p = 0.000$), with t-values > 7 for both relationships. Finally, the findings confirm that adopting green banking innovations significantly impacts market competitiveness (H7). The path coefficient was 0.478 ($p = 0.000$), with t-values > 8.

4.6. Discussion

The results confirm that regulatory pressure is a key driver of the uptake of green banking innovations, as supported by current literature (Bose et al., 2021; Khan et al., 2021; Park & Kim, 2020). However, while these works highlight the regulatory function in promoting green practice, they are less concerned with the extent to which such policies result in meaningful environmental benefits versus compliance. Banks are said to be able to take shallow green actions to meet regulatory requirements rather than pursuing deeper sustainable change. Second, while regulatory policies are shown to encourage sustainable bonds and green energy loans (Dong et al., 2021; Jain et al., 2022), the literature has not investigated extensively whether such policies involve financial costs that may deter small banks from investing in green innovations. Furthermore, although sustainability accounting and reporting demands are linked with technological innovation (Dong et al., 2021; Zhang, 2023), studies do not tend to control for variation in the adoption rates in developed and emerging markets. Moreover, while the impact of global agreements, such as the Paris Climate Agreement, has been mentioned (Light & Skinner, 2021), their effectiveness in different regulatory environments remains understudied. A more nuanced discussion should decide whether regulations trigger sustainable green innovation or short-term compliance responses.

The study confirms that CSR orientation positively influences the adoption of green banking innovations, which aligns with existing research (Bouteraa et al., 2021; Kulińska-Sadłocha, 2022). Although previous studies revealed CSR as a driver of sustainability, they sometimes lacked a critical examination of whether banks engage in green activities as a strategic brand move rather than from a genuine concern for transforming the environment. Some studies highlight how CSR-driven sustainability efforts are more likely to cater to financial goals than to virtuous green endeavors, raising the questions of whether banks would persevere with such efforts in the absence of consumer and regulatory pressure. Further, while the current literature points to the role of international treaties in guiding green banking policies (Khan & Johl, 2019), it fails to explore how these agreements are translated into actionable steps, especially in regions with minimal regulatory oversight. Similarly, consumer awareness of environmental concerns is linked to green financial products' marketability (Shinde, 2021; Sun et al., 2020), yet this argument does not fully capture whether demand can suffice to stimulate green banking innovation. In addition, while studies show that green technology innovations lead financial institutions to adopt environmentally friendly practices (Khaer & Anwar, 2022; Singh et al., 2023), it often disregards the infrastructural and financial limitations in place that may hamper adoption.

The results verified that the worldwide green trends influence the adoption of green banking innovations. These findings are consistent with past research, which noted that the growing concern for environmental conservation and sustainability policies encourages such institutions, financial in nature, to 'go green' (Bouteraa et al., 2021; Kulińska-Sadocha, 2021). They are also in agreement with the findings that international treaties and normative pressures lead banks to adopt environmentally oriented strategies about responsible resource utilization and global risk factors (Khan & Johl, 2019; Sun et al., 2020). In addition, studies have pointed out how increased consumer interest in green bond investments and financing for the energy transition creates new business prospects and encourages banks to expand their range of green products and strengthen brand value (Shinde, 2021; Singh et al., 2023). Advancements in technology have also been associated with the adoption of new green banking technologies which have aided the move towards paperless banking and energy-saving processes

(Khaer & Anwar, 2022). These observations suggest that the trend of adopting global green strategies is becoming more pronounced in terms of the sustainability strategies of banks. The trends in global environment policies will require the financial sector to step up their commitment to green technologies in order to gain a competitive advantage and ensure the growth of the sector.

The evidence also demonstrated that although the market demand for green products has often been mentioned as one of the key drivers for the adoption of green banking innovations, this study found its effect to be statistically nonsignificant. These results contrast with studies indicating that consumers are becoming environmentally conscious and will demand businesses to incorporate eco-friendly decisions and products (Mohd & Kauskal, 2018; Sharma et al., 2024). They also contradict earlier literature which stated that once clients are prepared to invest in products that are not environmentally harmful, institutions will design green bonds, low-emission credit cards, and other related features (Bouteraa et al., 2021; Stauropoulou et al., 2023). In addition, previous research has argued that banks will adopt modern technologies and eco-friendly practices as a result of environmental SMEs embracing green practices, forcing a demand for such solutions (Chien et al., 2021; Rodrigues & Franco, 2023). Earlier studies also suggested that such demand leads to a partnership between the banks and the environmental stakeholders in charge of making products that are environmentally friendly (Gangi et al., 2019; Alsmadi 2023b). Contrary to those expectations, our research did not find a significant market demand effect on green banking innovation and development, suggesting that such a link has to be less straightforward than assumed. One of the most important reasons is the lack of awareness of Jordanian bank customers regarding green banking products. Though there is greater concern for the environment globally, the application of green bank products such as green loans, green savings accounts, and green bonds may be in their infancy in Jordan. Consequently, customers may not appreciate or respect the environmental attributes of bank products and thus may not have a similar demand for the same. Such low demand could then be combined with the fact that most of the customers in Jordan continue to respect old-fashioned banking services more than newer, green services. Furthermore, the fact that banks have not advertised green banking products extensively and informed customers of their benefits may also be a reason for the lack of demand noticed in the study.

The results substantiated the expectation that green banking innovations are useful in enhancing operational efficiency. These findings are in line with analysts' arguments previously made in support of green banking, such as the use of paperless transactions, digitalization, and incorporating energy-efficient technologies, which support the internal efficiency of financial institutions (Aslam & Jawaid, 2023; Rehman et al., 2021). They also concur with studies that underline the role of steel banking, which lessens the dependency on paper-based banking, in managing costs and enhancing operational efficiency (Awan, 2023; Mallo, 2024). In addition, research has pointed out that the adoption of these technologies, including the use of solar-powered branches and the construction of energy-efficient buildings have proven to lower the costs of electricity and improve the efficiency of resource usage (Adeniran et al., 2024; Esho et al., 2024;). This evidence supports the assertion that green banking strategies increase the risk management capacity of poor environmental strategies and pressure from regulators (Hussain et al., 2024). Additionally, operational benefits attributable to such strategies are believed to be reinvested into the business to enable the organization to be more innovative and improve the business environment (Hussain et al., 2024). Lastly, the findings from recent literature show that these operational enhancements have a positive effect on the customers, as there is improved

service delivery owing to the adoption of digital and paperless systems, which are faster, more accurate, and more customer friendly (Nwosu et al., 2024).

Research has been shown that the incorporation of green banking practices substantially contributes to the promotion of environmental sustainability. Our findings confirm those studies, which show that incorporating environmental factors into banking activities minimizes the footprints of conventional financial activities (Khaer & Anwar, 2022; Zhang et al., 2022). They also align with studies focusing on how e-systems, e-statements, and online interactions reduce the occurrence of waste creation and deforestation, and promote better environmental quality (Lee, 2020; Zhang et al., 2022). Additionally, some evidence has indicated that concepts of green financing support investments in renewable energy and other ecologically friendly projects, which help to increase environmental protection measures and create multiple sustainability benefits (Bank, 2020; David & Venkatachalam, 2018; Gulzar et al., 2024). Furthermore, the use of green banking practices has also been reported to enhance the uptake of solar energy and other conservation practices, which leads to energy efficiency and reduced carbon emissions and sets an example in corporate behavior for climate protection (Bansal et al., 2019; Prabhu & Aithal, 2023). In total, these findings establish the effectiveness of green products such as green loans and green bonds that support environmentally friendly projects, leading to increased corporate accountability and global sustainability goals. As a final point, the evidence supports the view that the adoption of green banking innovations is helpful in enhancing ecological sustainability activities within the financial system.

The evidence demonstrates that the incorporation of green banking practices contributes to the competitiveness of the market. These findings support previous research emphasizing the relevance of green banking practices and strategies in the formation of consumer perceptions and overall competitive leverage (Hidayat-ur-Rehman & Hossain, 2024; Sharma et al., 2024). They also concur with the studies which investigated marketing strategies that endorse the deployment of a portfolio of environmental products such as renewable energy loans or green bonds, which enhance corporate image and market dominance (Javid et al., 2023; Taghizadeh-Hesary & Yoshino, 2020). Further, studies have shown that green banking initiatives go beyond building higher customer loyalty to cultivating their trust and goodwill, especially among individual and institutional clients searching for such eco-friendly financing services (Fahima, 2023; Javid et al., 2023). These results show that banks adopting and practicing eco-friendly measures have the potential to capitalize on first-mover advantages and thus become leaders in the market (Fahima, 2023). In addition, it has been argued that modern banking services that do not rely on paper usage and utilize energy-efficient practices may create internal resources that can be effectively used in building competitiveness and ensuring profitable growth in the market (Bose et al., 2021 Shershneva & Kondyukova, 2020). On the other hand, the potential to tap the new market around carbon credits and eco-savings accounts serves to further enhance the growth prospects of green banking, thus ensuring competitive advancement over time (Prabhu, 2021).

5. Conclusions, implications and future research

5.1. Conclusions

This study aimed to address gaps in the literature by developing a more comprehensive framework of the drivers and outcomes of adopting green banking innovations. Based on an analysis

of data collected from 217 senior executives, managers, and specialists from banks in Jordan, the output of smart PLS revealed that regulatory pressure and CSR orientation significantly impact the adoption of green banking innovations, with path coefficients of 0.404 and 0.190, respectively. Market demand for green products showed no significant effect. Meanwhile, global green trends significantly influence adoption, with a path coefficient of 0.230. The results also show that the adoption of green banking innovations significantly impacts operational efficiency and environmental sustainability, with path coefficients of 0.569 and 0.417, respectively. Additionally, adopting green banking innovations significantly affects market competitiveness, with a path coefficient of 0.478. According to the results, CSR orientation and global green trends explain 55.6% of the variance in the adoption of green banking innovations.

Our examination contributed fresh empirical proof to the relatively scant existing literature on banks in the use of ecologically responsible practices in Jordan. There has been some research and case studies, but not case studies in their natural habitat to understand the state of practice and the challenges banks face. Green banking practices, being at a nascent stage in Jordan, present opportunities for both academic pursuits and consultancy. This is necessary when regulations and conditions are happening at breakneck speed.

The banking sector is actively working to overcome the shortcomings of the 21st century; hence, green innovations in banking are proving to not only be useful but necessary in preparing against the increasing challenges posed by environmental regulations and consumer norms. This study's findings regarding the factors of development and the results of green innovations in banking enable their implementation in the practice of banking institutions which envisage a successful future in the changing context of world finance. These innovations allow banks not only to improve their operational effectiveness and their ability to compete in the market but also to participate in the development of society in the global shift towards sustainable development. This shift, backed by the strategic use of green banking, would radically change the face of banking in the era of environmental consciousness and set the pace for all other sectors in achieving a sustainable and prosperous future.

In summary, this study highlights the pressing need for regulatory pressure, CSR direction, and worldwide green movements toward fostering the adoption of green banking innovations, which would lead to greater operational efficiency, environmental sustainability, and business competitiveness. However, despite the potential confirmation of earlier studies, these findings also underscore the need to deeply examine whether the imperative of regulatory compliance equates to genuine effort for sustainability or merely ensures policy conformity. Additionally, the study's minimal results regarding the market demand for green products suggest that green banking innovations may be prompted not only by consumer demand, suggesting that other supporting factors such as financial incentives and technological innovation must be investigated. Future studies will need to strive to examine the long-term impacts of adopting green banking, assess policy variations between regions, and validate the convergence of green banking and new financial technologies. Moreover, incorporating qualitative information about policymakers and business leaders could help enhance the perception of strategic decision-making in green finance.

5.2. Policy implications

This study's results indicate that there are regulatory tendencies, CSR inclinations, and worldwide green trends that need emphasis, as they lead to the incorporation of green banking innovations in these

institutions. For regulators and policymakers concerned about creating the conditions necessary for the growth of sustainable banking, these lessons are important. By appreciating the complex relationships between these factors and green banking practices, policymakers will be able to devise appropriate strategies that not only seek to protect the environment but also increase the competitiveness of financial institutions in a green economy. The research in this paper, however, draws attention to the fact that a more comprehensive approach to regulation is required, including measures that go beyond simply ensuring compliance and that actively encourage innovation within green banking. Policymakers in the regulatory agencies may wish to develop policies that provide specificity and positive incentives for the greenest practices and for the earliest adopters within the banking industry.

5.3. Implications for banks

Banks are able to use such insights to come up with improved green finance strategies via aligning their CSR interests with green banking innovations. Incorporating sustainability into business models will enable banks to differentiate in the competitive marketplace. Additionally, mutual coordination with regulators for guidelines on sustainable finance can optimize their long-term profitability and environmental response. By focusing on customer awareness and incorporating green products into their portfolios, banks are able to capitalize on growing global and regional environmental awareness.

5.4. Limitations and future research

This research, in spite of its inclusivity at some level, has some constraints which provide directions for further exploration. First of all, the scope of our conclusions is limited, given the focus on the banking sector of Jordan, which is probably specific to the local context and may not capture the many green banking innovations being implemented across the globe. Future studies could examine these innovations in other countries or regions and determine the influence of the regulatory system, the institutional setting, and the socio-cultural context in the embracing of green banking practices in such countries or regions. Second, the data emanating from banks in Jordan as our main source could expose us to self-reported biases. This limitation has already been predicted in research by suggesting the use of external audit reports or independent evaluations for validating the banks' assertions regarding the use and effects of the reported green banking practices. This would improve the credibility of the findings and limit the scope of response bias or social approval bias affecting the findings. Thirdly, the cross-sectional design used in this study does not permit us to make conclusions regarding the cause-and-effect relationship between green innovations and the operational efficiencies and environmental concerns that were noted. Such patent relationships need to be explored across a timeframe, which would give better insights into the green banking trends' causation and their lasting impact in the future.

For instance, the study's focus on the analysis and operationalization of intricate dimensions such as regulatory pressure or CSR orientation could overlook some intricacies that characterize these aspects. Further studies could devise better measurement tools for the constructs covered here or use other proxies that would more comprehensively address issues around the measurement and the validity of the constructs. Finally, further research could examine the mediating and moderating effects of variables that were not examined in the present study, such as the organization culture, style of leadership, or technological support. Such studies could provide a more vivid picture of the processes

of how green banking technologies affect the operational practices of the banks and their level of competitiveness in the market.

Author contributions

Ayman Abdalmajeed Alsmadi led the construction of the research framework and supervised the collection and analysis of the data while establishing the theoretical context. His contributions extend to the drafting and reviewing of the manuscript concerning the intellectual content of the work.

Khaled Saleh Al-Omoush contributions to the literature review, data analysis and interpretation, and the measurement model validated through Smart PLS are recognized. He aided in the writing of the results, discussion, and implications and participated in the editing of the final manuscript.

Both authors claim to collaborate and claim full responsibility for every part of the manuscript.

Use of AI tools declaration

The authors declare they have not used artificial intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

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