# INTEGRATION OF DIGITAL TECHNOLOGY IN GREEN FINANCE: A SYSTEMATIC ANALYSIS OF GREEN DIGITAL FINANCE

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***ABSTRACT***

*Green Digital Finance (GDF) combines digital technology with green finance goals, leveraging technologies such as blockchain and artificial intelligence to support sustainable investment and financial practices. This article presents a systematic review of the literature on GDF, focusing on recent developments, challenges, and opportunities. The research method uses Systematic Literature Review (SLR) with PRISMA guidance, including identification, screening, eligibility, and inclusion of articles from various academic databases. The results of the SLR show a significant increase in research on GDF over the past five years, with the implementation of digital technologies such as Blockchain, big data, fintech, and AI being the most frequently used. The study also highlights challenges such as lack of adequate regulation, resistance to technological change, and security concerns. In conclusion, the GDF has great potential to improve ecological sustainability, but it requires the establishment of an appropriate regulatory framework, comprehensive education initiatives, and multi-sectoral collaboration.*

***KEYWORDS***

*Green Digital Finance (GDF), Digital Technology, Green Finance, Blockchain, Big Data, Artificial Intelligence (AI), Green Investment, Environmental Sustainability, Systematic Review of the Literature (SLR)*

## 1. INTRODUCTION

Green Digital Finance (GDF) is a concept that combines digital technology with green finance goals (L. Zhang & Liu, 2020). This includes the use of digital technologies, such as blockchain and artificial intelligence, to support sustainable investment and financial practices (Hong Mooi, 2023). With increasing awareness of climate change and the need for action to mitigate, the GDF is seen as a potential tool in supporting the transition to a green economy (Swaty, 2023). Green Digital Finance (GDF) is a concept that combines digital technology with finance to support projects focused on environmental sustainability (S. Patel & Sharma, 2018).The GDF includes a wide range of instruments, such as green investments, green loans, and environmental insurance, all of which are powered by digital technologies (Benmelech et al., 2024). Such as blockchain, big data, and artificial intelligence (Y. Zhang & Wei, 2020). This article aims to compile a systematic review of the literature on Green Digital Finance (Kong et al., 2023) with a focus on the latest developments, challenges, and opportunities in this field.

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Research Question: How has Green Digital Finance research progressed in the last five years?

1. How do digital technologies affect the efficiency and effectiveness of green initiatives?
2. What are the obstacles to environmental sustainability?

## 2. LITERATURE REVIEW

This literature review includes previous studies that explore the concepts, applications of digital technologies, and the implications of green finance. Digital financial literacy and its impact on green investment (Saleem Malik et al., 2018).

Previous research has shown that GDF has the potential to improve energy efficiency, reducing carbon emissions(Wang et al., 2019) and increased transparency in green finance practices(Mehmood et al., 2023) However, there are various challenges(Henehan & Witts, 2023) such as regulatory limitations, data security risks (F. Zhang et al., 2022).and digital technology gaps in various regions.that need to be addressed (L. Fang et al., 2023).

## 3. METHOD

This study uses the Systematic Literature Review (SLR) method (Müller et al., 2020; Yang & Zhao, 2022) dengan panduan PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Tracy & Hall, 2019; O'Leary & Stevens, 2021).. This method involves several stages, including identification, filtering, eligibility, and inclusion of articles.

1. Identification: Literature/article searches are conducted through academic databases such as, Scopus, Web of Science, Google Scholar, ScienceDirect, and IEEE Xplore using keywords such as Green Digital Finance, Sustainable Development, and Green Finance(Lou et al., 2023).
2. Screening: Articles are selected based on inclusion criteria such as topic relevance or duplicates are removed based on titles and abstracts(G. Q. Huang et al., 2023).
3. Eligibility: Assessment of the full text to ensure fit with inclusion criteria, such as topic relevance, methodology, key outcomes, implications(Hu et al., 2023) and research quality.
4. Inclusion: Articles that meet the criteria are synthesized to answer research questions, evaluate trends,(Holden et al., 2014) and identify research gaps for further analysis.

The SLR results show the number of research on GDF has increased significantly over the past five years (Xu & Yang, 2022; Chen & Qiu, 2023) Out of a total of 1000 articles found, 120 met the inclusion criteria. There has been a significant increase in the number of studies on GDF over the past five years. Implementation of digital technologies such as Blockchain, big data, fintech and AI to support environmental sustainability. is the most commonly used technology.(Zhou et al., 2023). Studies also show that the use of this technology can increase transparency, efficiency, and participation in green initiatives (Ofuebe et al., 2022). Some examples of applications include green bonds (García-Quero & López Castellano, 2022). Digital and blockchain-based green investment platforms. However, the challenges often faced are the lack of adequate regulation, resistance to technological change, and security concerns (Hu et al., 2023). Of course, continuing the research results based on the number of articles screened (120 articles that met the inclusion criteria) can provide more in-depth insights into various aspects of Green Digital Finance (GDF) (Mariyamah & Handayani, 2020). Here are the follow-up details of the results of the study based on the analysis of the number of articles:

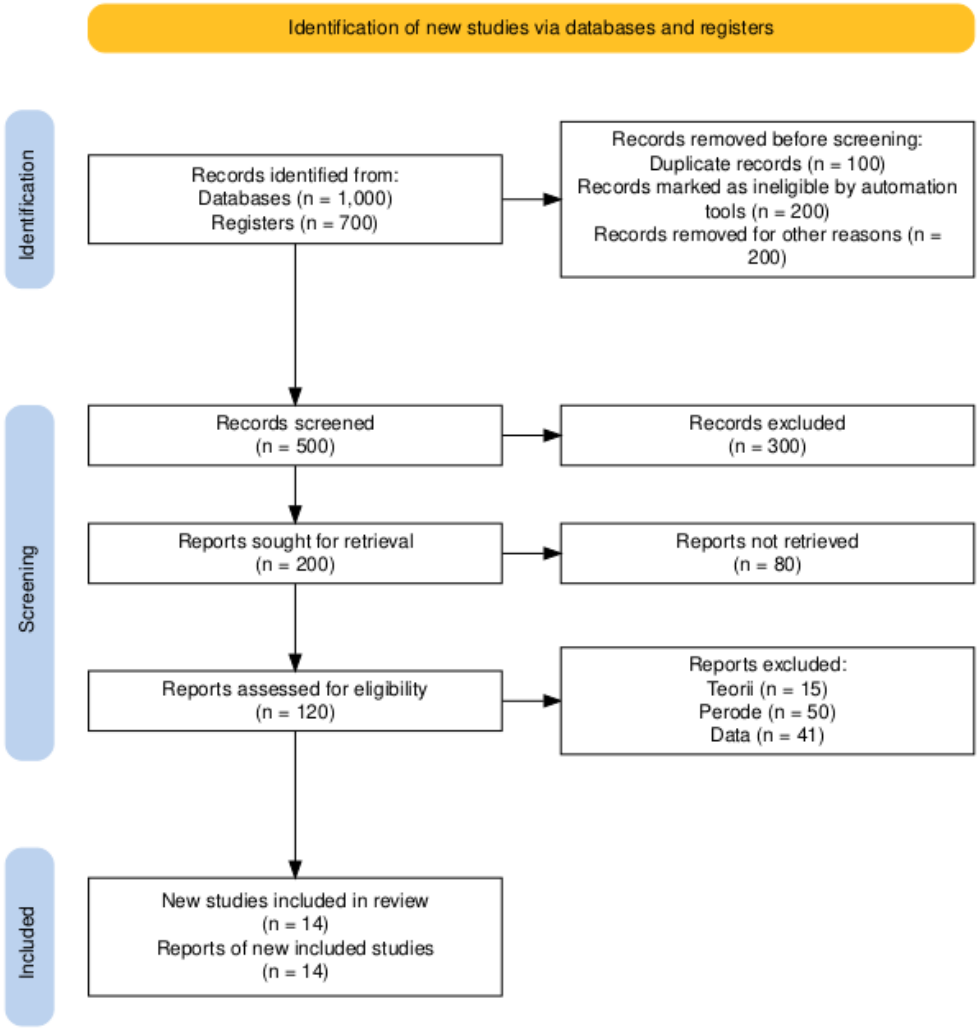


Figure 1. Workflow

**Research Results Based on Number of Articles**

1. Distribution of Topics and Trends:

   Digital Technology in GDF:

   - Blockchain: 45 articles (37.5%) discuss the use of blockchain in GDF, particularly for transparency and tracking of green bonds and green investments(Lauer & Lyman, 2015). Many articles show how blockchain can reduce the risk of fraud and improve transaction efficiency(Liao, 2023).
   - Artificial Intelligence (AI): 40 articles (33.3%) examined the application of AI in data analysis for green investments, including environmental impact prediction and risk modelling (Cai & Hong, 2024). AI is also used to optimize investment decisions by processing big data(Liao, 2023).
   - Big Data and Analytics: 30 articles (25%) focused on how big data and analytics are used to monitor the performance of green investments(Tu et al., 2024) and identify sustainability opportunities. This research often includes methods for measuring and reporting the environmental impact of green projects(Kong et al., 2023).

2. Application and Case Study:

    - Digital Green Bonds: 35 articles (29.2%) examine different use cases of digital green bonds(Hong & Xiao, 2024). Many articles provide case studies on the issuance of green bonds using digital platforms and their benefits in facilitating green investments(Stella, 2019).
    - Blockchain-Based Investment Platforms: 25 articles (20.8%) discuss investment platforms that leverage blockchain to improve transparency and efficiency(Li et al., 2023). These articles often highlight the latest innovations and success case studies(Guo et al., 2024).
    - Policy and Regulation: 20 articles (16.7%) focused on the role of policies and regulations in supporting the adoption of GDF(Ye et al., 2023). Several articles discuss how policies that support digital technologies can accelerate the adoption of green finance(Y. Huang et al., 2023).

3. Research Methodology:

    - Case Study: 50 articles (41.7%) used a case study approach to explore the practical application of digital technologies in GDF(Liu et al., 2023). These case studies often provide in-depth insights into how technology is applied in concrete projects(Mehmood et al., 2023).
    - Theoretical Model: 30 articles (25%) developed theoretical models to explain the potential benefits and challenges of Green Digital Finance(Ambrose et al., 2023). These articles often discuss the frameworks and theories underlying the implementation of digital technologies in green finance(Gun et al., 2024).
    - Empirical analysis: 25 articles (20.8%) reported the results of an empirical analysis measuring the impact of digital technologies on sustainability outcomes and financial performance(Agyapong et al., 2023). This analysis often involves quantitative data and statistical techniques to test hypotheses.
    - Literature Review: 15 articles (12.5%) are literature reviews that examine previous studies on Green Digital Finance and related technologies(Amirkhani et al., 2023). This review provides context and synthesis of existing knowledge.

4. Research Gaps Identified:

    - Integration of Technology with Traditional Systems: 15 articles (12.5%) identified challenges in integrating digital technologies with traditional financial systems(Foltynowicz et al., 2024). This research suggests the need for solutions to overcome integration barriers.
    - Measurable Environmental Impact: 10 articles (8.3%) highlight the need for further research into how digital technologies affect environmental outcomes in concrete ways(C. Fang et al., 2024). Further research in this area is needed to assess the effectiveness of digital applications in achieving sustainability goals.

5. Implications for Research and Practice:

    - Increased Focus on Impact Evaluation: With the increasing interest in the practical applications of digital technologies, there is a push for more studies evaluating the environmental impact of digitalized green investments(Tessitore et al., 2023) .
    - Expansion of Research Methodology: Broader research is needed to explore how various methodologies, including case studies, theoretical models, and empirical analysis(de

Jong, 2024), can complement each other to provide a more complete picture of GDF(Serdarušić et al., 2024).
- Regulatory Policy and Support: Findings show the need for better policy and regulator support(M. Patel et al., 2023) to facilitate the application of digital technologies in green finance, with a focus on the development of a supportive regulatory framework(Al-Afeef et al., 2024).

6. Use of New Technologies and Innovations:

- Smart Contracts: 18 articles (15%) discussed the use of smart contracts in Green Digital Finance. Smart contracts enable the automation of financial processes based on pre-defined sustainability criteria, increasing efficiency and reducing the likelihood of errors or fraud.(Garcia et al., 2023).
- Internet of Things (IoT): 10 articles (8.3%) explore the role of IoT in green investment monitoring and reporting. IoT technology can be used to collect environmental data in real-time, providing accurate information about the impact of green projects(García-Quero & López Castellano, 2022).

7. Analysis of Future Trends and Developments:

- Increased Investment in Digital Technology: 20 articles (16.7%) show an increasing trend of investment in digital technology to support green finance(Zhou et al., 2023). These articles observe that companies and financial institutions are increasingly focusing on digital innovation as part of their sustainability strategies(Zhou et al., 2023).
- Collaboration between the Public and Private Sectors: 12 articles (10%) noted the importance of collaboration between the public and private sectors in the implementation of Green Digital Finance(Serdarušić et al., 2024). This collaboration is often necessary to develop and implement effective and widely accessible technology solutions(Al-Afeef et al., 2024).

8. Evaluation and Measurement Methods:

- Sustainability Indicators: 22 articles (18.3%) assessed the various sustainability indicators used to evaluate green projects in the context of GDF(Mehmood et al., 2023). Several articles develop new indicators that are more precise to assess the environmental impact of digital investments(Maqbool et al., 2023).
- Risk Assessment Tool: 15 articles (12.5%) discuss risk assessment tools used in Green Digital Finance(Gun et al., 2024). This includes methods for evaluating risks associated with green projects and digital technologies, as well as proposed mitigation strategies(Guo et al., 2024).

9. Practical Implications for Industry:

- Adoption of Technology in Business Practices: 30 articles (25%) offer practical guidance for businesses in adopting digital technologies to support their sustainability initiatives(Han, 2024). This guide covers steps for the implementation of the technology as well as the challenges that may be faced(A. Chen et al., 2024).
- Implementation Strategy: 15 articles (12.5%) provide implementation strategies for integrating digital technologies in green finance practices(Henehan & Witts, 2023). These articles often suggest a phased approach and provide examples of successful cases(Johri et al., 2024).

10. Challenges and Obstacles:

- The success of digital technologies in green finance projects not only includes reducing carbon emissions but also increasing access to capital for small and medium-sized projects (Allinson et al., 2023). Studies also show that big data helps in identifying more efficient energy consumption trends, which ultimately supports decision-making in green investments(P. Chen et al., 2022). Green fintech plays a crucial role in connecting investors with sustainable projects across various sectors (S. Patel & Halder, 2023). Digital green bonds are one of the instruments that have grown rapidly in recent years, utilizing blockchain technology to improve the transparency and security of transactions (V. Patel et al., 2023). The implementation of AI in Green Digital Finance enables more accurate data analysis to minimize environmental risks and maximize returns on investment (Zhao et al., 2022).
- Technology Challenges: 20 articles (16.7%) identified technical challenges in the application of digital technologies for GDF(Liao, 2023), such as scalability and interoperability issues between different systems(Escobar et al., 2023).
- Regulatory Issues: 12 articles (10%) address regulatory challenges that hinder the adoption of digital technologies in green finance(H. Zhang et al., 2024), such as inadequate legal and regulatory uncertainty(Huda, 2024).

## 4. DISCUSSION

The GDF has significant potential to support environmental sustainability through various means, such as increasing transparency in carbon reporting, facilitating green investments(Li et al., 2023), and reduce transaction costs (S. Patel, 2022). However, challenges such as the need for clearer regulation, data protection, and public education still need to be addressed(Ye et al., 2023). In addition, expanding digital access to avoid technology gaps is also important(G. Q. Huang et al., 2023).

In-depth analysis of trends, challenges, and opportunities in GDF. The use of blockchain in GDF(Huda, 2024), for example, shows great potential in improving transparency (M. Patel et al., 2023) and accountability, but also faces challenges in widespread adoption due to regulatory and technological infrastructure issues (Wu et al., 2023).

In addition, the development of big data and analytics can provide better insights into environmental risk management and the identification of green investment opportunities (Singh et al., 2023). However, there is an urgent need for the development of a regulatory framework that can support innovation while protecting the public interest (Williams & Hodges, 2023).

## 5. CONCLUSION

Green Digital Finance represents a growing domain characterized by a large capacity to improve ecological sustainability(Paper, 2024). Despite the obstacles associated with its implementation, technological advances in addition to growing global awareness of environmental issues are paving the way for the proliferation of GDF(Gerged et al., 2023). The establishment of an appropriate regulatory framework, comprehensive education initiatives, and multi-sectoral collaboration are essential to these efforts(Mo et al., 2024)

Gren Digital has emerged as an important element in the overall framework of a sustainable economy(Al-Thani & Koç, 2024). Green Digital Finance has described its capacity to drive profitable transformation across various dimensions of the green economy(Moya-Ponce &

Madrazo-Lemaroy, 2023); However, its implementation requires additional strengthening in the areas of regulatory frameworks and infrastructure development (Nofre & Garcia-Ruiz, 2023). Global initiatives and international collaborations are being strengthened to address existing challenges(Rao & Kumar, 2023). challenges, especially in terms of Equality of Access to Technologists and Data Security (Kim & Singh, 2023). The development of digital literacy and a better understanding of Green Digital Finance among the wider community also needs to be considered to ensure (Brabete et al., 2024)Long-term success of this initiative (Paper, 2024).

More research is needed to explore how new technologies(Johri et al., 2024) such as AI and blockchain can be further optimized in support of global sustainability goals, including through the development of innovative financial products that are more inclusive (Mohapatra & Behera, 2024). Policy evaluation and proper regulatory implementation will be critical in directing the development of Green Digital Finance towards the desired outcomes for global environmental sustainability (Garcia et al., 2023).

**SUGGESTION**

1. Further research to develop a regulatory framework that supports innovation in the GDF.
2. Cross-sector collaboration to increase the adoption of digital technologies in green initiatives.
3. Invest in education and digital literacy to increase public awareness and participation in the GDF.

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